Task Order No. 832
Contract No. PCE-I-96-00002-00

HAZARDOUS AND NON-HAZARDOUS SOLID WASTE MANAGEMENT IN THE 10TH OF RAMADAN INDUSTRIAL CITY

Volume 1

By
Avijit Dasgupta PhD P.E.
Mostafa Eissa
Lane Krahl
Leo R. Larochelle P.E.

June, 2000

For
Egyptian Environmental Policy Program
Program Support Unit

Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)

Disclaimer

The comments in this report on the proposed design of the hazardous waste landfill for the 10th of Ramadan Industrial City are those of the authors of the report and do not necessarily reflect the views of USAID.

Contents

Preface

Through competitive bidding, the U.S. Agency for International Development (USAID) awarded a multi-year contract to a team managed by International Resources Group, Ltd. (IRG) to support the development and implementation of environmentally sound strategic planning, and strengthening of environmental policies and institutions, in countries where USAID is active. Under this contract, termed the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ), IRG is assisting USAID/Egypt with implementing a large part of the Egyptian Environmental Policy Program (EEPP).

This program was agreed-to following negotiations between the Government of the United States, acting through USAID, and the Arab Republic of Egypt, acting through the Egyptian Environmental Affairs Agency (EEAA) of the Ministry of State for Environmental Affairs, the Ministry of Petroleum's Organization for Energy Planning, and the Ministry of Tourism's Tourism Development Authority. These negotiations culminated with the signing of a Memorandum of Understanding in 1999, whereby the Government of Egypt would seek to implement a set of environmental policy measures, using technical support and other assistance provided by USAID. The Egyptian Environmental Policy Program is a multi-year activity to support policy, institutional, and regulatory reforms in the environmental sector, focusing on economic and institutional constraints, cleaner and more efficient energy use, reduced air pollution, improved solid waste management, and natural resources managed for environmental sustainability.

USAID has engaged the EPIQ contractor to provide Program Support Unit (PSU) services to EEPP. The PSU has key responsibilities of providing overall coordination of EEPP technical assistance, limited cross-cutting expertise and technical assistance to the three Egyptian agencies, and most of the technical assistance that EEAA may seek when achieving its policy measures.

The EPIQ team includes the following organizations:

- Prime Contractor: International Resources Group
- Partner Organizations:
  - Winrock International
  - Harvard Institute for International Development
- Core Group:
  - Management Systems International, Inc.
  - PADCO
  - Development Alternatives, Inc.
- Collaborating Organizations:
  - The Tellus Institute
  - KBN Engineering & Applied Sciences, Inc.
  - Keller-Bliesner Engineering
  - Conservation International
  - Resource Management International, Inc.
  - World Resources Institute's Center For International Development Management
  - The Urban Institute
  - The CNA Corporation.

For additional information regarding EPIQ and the EEPP-PSU, contact the following:

United States of America:

EPIQ Prime Contractor
International Resources Group, Ltd
1211 Connecticut Ave, NW
Suite #700
Washington, DC 20036
Telephone: (1-202) 289-0100
Facsimile: (1-202) 289-7601

Egypt:

EEPP-PSU
International Resources Group, Ltd
21 Misr Helwan Agricultural Road
Office 62, 6th Floor
Maadi, Cairo
Telephone: (20-2) 380-5150
Facsimile: (20-2) 380-5180

Contact: Douglas Clark Contact: Harold van Kempen

Acronyms

CDA	City Development Agency
EEAA	Egyptian Environmental Affairs Agency
EEPP	Egyptian Environmental Policy Program
EFNIC	Environment Friendly New Industrial Cities program
EPIQ	Environmental Policy and Institutional Strengthening Indefinite Quantity Contract
GOE	Government of Egypt
IEMS	Integrated Environmental Management System
L.E.	Egyptian Pound
MHCNC	Minister of Housing, Construction and New Communities
MSEA	Ministry of State for Environmental Affairs
OECA	Office of Enforcement and Compliance Assurance of the USEPA
TCLP	Toxicity Characteristic Leaching Procedure
TSDF	Hazardous waste treatment, storage, and disposal facility
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency

Executive Summary

Work is progressing in the development of a hazardous and non-hazardous solid waste management system for the 10th of Ramadan Industrial City. A database is under development under the auspices of the Environment Friendly New Industrial Cities program (EFNIC) to identify the sources, quantities and types of solid waste generated at industries in the city. In parallel, a private shareholder company has been established to undertake environmental projects in the city, including development of a hazardous waste disposal facility. The progress for each of these important developments is paced by the intent of designating the 10th of Ramadan Industrial City as an environmentally friendly city in the year 2000.

This report provides evaluation and recommendations by which the work done to date can be translated into effective sustainable solid waste management processes and facilities. Specifically, the scope of work for this evaluation identifies three distinct objectives. The following is a general synopsis of findings and recommendations for each of the three objectives.

Objective 1 - Identify the technical data needs for comprehensive hazardous and non-hazardous waste management for the 10th of Ramadan Industrial City.

In Egypt, the process is still evolving for defining hazardous waste and developing regulations and procedures for managing those wastes. The lack of a national classification system has hampered data collection on hazardous and non-hazardous solid waste. Without a clear definition of what constitutes hazardous waste, it is impossible to maintain a consistent database and produce the data necessary to design a management system. The need for a classification system can clearly be seen in the EFNIC database for the 10th of Ramadan, in which 92 percent of the material currently reported as hazardous waste is furnace slag from facilities that recycle metal. This material may or may not be a hazardous waste depending upon the waste classification system requirements. It would not be considered a hazardous waste in the United States.

The team recommends that Egypt adopt a hazardous waste classification system similar to that used in the United States, in the Basel Convention, and proposed by the Ministry of Industry and Mineral Resources. Until Egypt adopts a system, the team recommends that EFNIC use the United States system to classify wastes in its database.

During its mission, the team reviewed the structure and content of the EFNIC database. The review was aimed at optimizing this database for use as a practical planning tool for implementation of management processes and facilities. The team concluded that although EFNIC has made a good start at collecting data from industrial facilities, more information is necessary for the design of waste management systems.

Many anomalies exist in the database. Often, facilities with similar manufacturing processes and production levels had significant differences in the type and quantity of waste reported in the database. The team identified several changes in the structure of the database that would facilitate cross-checking of data so that anomalies could be identified and corrected or at least explained. The team also recommended improving the data collection procedures.

To that end, the team conducted a half-day workshop on collection and analysis of hazardous and non-hazardous waste data, attended by 20 EFNIC inspectors.

The "type of waste" and "means of disposal" entries in the database are often not precise enough for adequate waste planning. For instance, in many cases, the type of hazardous waste is identified only as oils, chemicals, containers, sludge, or inks. Type of disposal is often listed as "sold" or "safe." Once EFNIC adopts an interim hazardous waste classification system, it should use the categories of wastes in the system as the designators for "type of waste" in the database. It needs to expand and define the terms used for means of disposal.

After EFNIC modifies the database structure, adopts a classification system, develops detailed questionnaires and flow diagrams, and trains its staff, it will need to revisit the facilities with the greatest potential for waste generation and collect more detailed information. Once accuracy and thoroughness has been achieved, the information contained in the database can be used plan for new facilities that will comprise the integrated solid waste management program for the 10th of Ramadan.

Objective 2 - Provide comments on the proposed hazardous waste landfill for the 10th of Ramadan Industrial City.

A preliminary schematic design was prepared for EFNIC by an Egyptian engineering firm for a hazardous waste landfill in the 10th of Ramadan Industrial City. The team reviewed the design and provided comments on it to EFNIC. Because Egypt has not adopted design standards for hazardous waste management facilities, this report includes general standards that were used in the review of the proposed design. It also includes a description of a risk-based design process by which options available for critical elements, such as liners and leachate control systems, can be evaluated and specified. These general standards can provide guidance to the Government of Egypt as it develops its own hazardous waste management standards.

The preliminary design for the hazardous waste landfill has many of the necessary components including a liner; access road and controlled access point; administrative, security and maintenance structures and landscaping; and utilities, lighting, and fencing. However, many other components are not present in the design, including leachate collection, treatment and disposal; groundwater monitoring; gas collection; and a cover system. Although the design does include a liner, the specification for the liner is problematic and could result in a liner failure. Considerable work is necessary to incorporate the missing components and redesign the liner system before the design can be used to conduct feasibility studies.

The scope of work for the team's activities does not include the preparation of feasibility studies. Neither sufficient data on the types and quantities of waste generated nor adequate specifications for facility design are currently available for conducting feasibility studies. However, the team did conduct a very preliminary assessment of the financial feasibility of the proposed landfill. This preliminary analysis indicated that the necessary fee to recover the full cost of the landfill could be as much as six times the current cost to industry of disposing hazardous waste. Under current conditions it is highly unlikely that this fee could be collected because of the lack of hazardous waste management standards and the relatively weak institutional capability in the city to enforce waste management regulations and collect fees for waste management. To overcome these institutional barriers to potential success, the team recommends implementation of the Integrated Environmental Management System (IEMS) in the 10th of Ramadan Industrial City.

To allow time for the development of a comprehensive hazardous waste management program, proper design of a waste disposal facility, and implementation of the IEMS, the team recommends the development of an interim hazardous solid waste storage facility. This will allow for a near term separation of hazardous waste from the mixed waste stream brought to the current disposal area. Removal of hazardous waste from the solid waste stream will help achieve an important benefit by isolating hazardous waste from direct contact by informal recyclers at the disposal area. It will initiate the hazardous waste management activity in the city and create awareness among the industries. It will also be an important element to demonstrating significant progress in developing an effective hazardous waste management program in the year 2000.

Objective 3 - Create a road map for the development of integrated systems for hazardous and non-hazardous waste management in the 10th of Ramadan Industrial City.

Work to date demonstrates the recognition by the Ministry of State for Environmental Affairs and the City Development Agency that effective hazardous and non-hazardous solid waste management must be accomplished in the 10th of Ramadan Industrial City. To that end, the evaluation team outlined implementation steps in four critical areas: development of the database, development of a hazardous waste disposal area, development of a non-hazardous waste management system, and development of a supporting institutional program. Some of the critical implementation steps are:

1. Revise and complete the 10th of Ramadan industrial waste database for use in planning and to serve as a model for other industrial cities.

2. Adopt an interim hazardous waste classification system for use in the 10th of Ramadan Industrial City.

3. Develop an interim hazardous waste storage facility.

4. Develop design and operational standards for hazardous management and detailed terms of reference for a permanent hazardous waste management facility.

5. Develop hazardous waste standards and regulations and local implementing capacity.

6. Complete the design and construction of an effective hazardous waste management facility to serve the 10th of Ramadan industries for the long term.

7. Improve standards of operations at the current city dumpsite.

8. Commence effective planning for disposal of non-hazardous solid waste.

1 Introduction

This report has been prepared by the Egyptian Environmental Policy Program (EEPP) to support the implementation of effective hazardous and non-hazardous solid waste management in the 10th of Ramadan Industrial City. EEPP focuses on achieving 15 policy objectives. This report has been prepared in support of policy objective 9: "MSEA/EEAA, in cooperation with industrial stakeholders and relevant GOE entities, develop pollution reduction strategies through higher rate of compliance."

This report was prepared by a four person team, under the supervision of the Program Support Unit of the EEPP and in cooperation with the Environment Friendly New Industrial Cities program (EFNIC) of the Ministry of State for Environmental Affairs (MSEA). The scope of work for the team is presented in Appendix A. The primary objectives of the team were:

- Identify the technical data needs for comprehensive hazardous and non-hazardous waste management for the 10th of Ramadan Industrial City.

- Provide comments to the government of Egypt on the proposed hazardous waste landfill for the 10th of Ramadan Industrial City.

- Create a road map for the development of integrated systems for hazardous and non-hazardous waste management in the 10th of Ramadan Industrial City.

The team conducted its fieldwork in December 1999. During that time it reviewed existing information and data on waste generation and management in the 10th of Ramadan Industrial City, conducted interviews with private sector and governmental officials (Appendix B), and toured industrial facilities and waste disposal areas. In addition to the 10th of Ramadan, the team interviewed officials and toured industrial facilities and waste disposal sites in the 6th of October Industrial City, and interviewed investors from Sadat Industrial City.

One team member, Avijit Dasgupta, returned to Cairo in March 2000. During that time, he worked with the EFNIC staff to revise the questionnaires they use to collect data, developed industrial flow diagrams, and conducted training.

To provide training to the EFNIC staff in the collection and analysis of data on hazardous and non-hazardous waste generation and disposal, the team conducted a half-day workshop on December 19, 1999. The workshop was held in the training room at EEAA and was attended by 20 EFNIC inspectors.

Another training event was held in on March 26, 2000 in the 10th of Ramadan for managers and engineers from the industrial facilities. The training materials presented at the events are included in this report as Appendix C.

The team believes that the work done to date by EFNIC in the development of an industrial solid waste generation database establishes a firm foundation for the future implementation activities outlined in this report. The aim of this report is to provide support to the current effort and, drawing upon the experience of the team in accomplishing similar programs in other countries, provide a basis through which the current effort can be refined. The report is also aimed at achieving progress within the limitations of current fiscal resources and the state of development of an effective regulatory enforcement structure.

2 Background

2.1 The 10th of Ramadan Industrial City

The 10th of Ramadan Industrial City is the oldest and largest new industrial city in Egypt. The population of Egypt is approximately 65 million. The rate of population growth in Egypt reached about 2.3 percent for the period of 1970-1980, then jumped to 2.8 percent for the period of 1980-1990. The majority of this population lives in the Nile Valley, representing less than 4 percent of the country's area. In the late 1970s, the GOE launched a program to establish new industrial cities away from the conventional urban areas. The purpose of this program was to attract industry and, as a result, part of the population out of the Nile Valley.

The GOE used many political and economic instruments to achieve this goal. It promulgated Law No. 59 of 1979 for Establishing New Communities. The law created the New Communities Authority in the Ministry of Housing, Construction and New Communities (MHCNC) to administer a City Development Agency for each new industrial city. The law provided land and utilities for industrial and residential purposes at subsidized prices. It also gave a 10-year tax exemption for all types of projects established in the new cities. By mid-1999, there were 11 new industrial cities under development with 2,352 production factories, providing about 2.7 million jobs.

The 10th of Ramadan Industrial City was the first of the industrial cities established, and is currently the largest industrial city in Egypt. The construction of the city began in 1978. The current plan is to build the city through four development phases. The first two phases have been completed. Work is proceeding on the third phase of the city and the fourth phase of the development process should be completed by 2017. By mid-1999, the number of producing industrial plants in the 10th of Ramadan reached 961 with 144,000 workers. The full-time residential population of the city is about 50,000. The other workers commute to the city daily from Cairo and Sharkia.

2.1.1 The 10th of Ramadan Local Administration System

The local administration in the 10th of Ramadan Industrial City, as well as in the other new industrial cities, is different from that of other cities in Egypt. The new industrial cities are considered to be under construction. As such, each city is managed by a City Development Agency (CDA) established by and reporting to the New Communities Authority in the MHCNC. Instead of a Local People's Assembly, as exists in other cities, the new industrial cities each have a Board of Trustees established and formed by a Ministerial Decree of the MHCNC. It is understood that after construction of the cities is complete, the administrative responsibility will be transferred to the Governorates, which regularly administer cities in Egypt. For the 10th of Ramadan, the administrative unit will be Sharkia Governorate.

The CDA in the 10th of Ramadan Industrial City has a president who is assigned by the MHCNC. The CDA consists of four major central departments: 1) City Development, 2) Finances and Real Estate, 3) Implementing Affairs, and 4) Projects. Each department administers its responsibilities through sub-sections. The current Board of Trustees for the 10th of Ramadan Industrial City was established under Ministerial Decree No. 359 issued on December 10, 1997. The Board has the following members:

One representative of the New Communities Authority,
Four representatives of the CDA (including its president as the Vice Chair of the Board of Trustees),
Ten investors (the Chair of the Investors Association, 8 industrial investors and 1 agricultural investor),
Eleven representatives, one from each of the governmental under-secretaries in the city such as Education, Health, Police, Labor (Industrial Safety), etc.,
Four representatives of residential units (including one youth representative and one representative for homemaker), and
One representative of the city's university.

According to the MHCNC Ministerial Decree No. 152 of 1994 for establishing Boards of Trustees for new industrial cities, some of the responsibilities of the Board of Trustees are:

1. Participating in city development programs and recommending expansion plans, financial resources, and project priorities to be submitted to the New Communities Authority for approval.

2. Studying the operational systems and procedures of the city's service units and activities and providing recommendations for improving their operational efficiency.

3. Recommending a clear and stable policy to increase the pace of city development according to established priorities.

4. Defining and approving self-financing plans to support city development.

5. Recommending systems for cleanliness, beautification, and maintenance activities in order to achieve balanced growth and comprehensive development of the city.

2.1.2 Integrated Environmental Management System

From 1997 through 1998, USAID sponsored an initiative to design an Integrated Environmental Management System (IEMS) for the 10th of Ramadan Industrial City. The objective of the program was to integrate command-and-control elements with market-based incentives to help both the government and private sector achieve compliance with the environmental regulations in Law No. 4 of 1994 in an efficient and cost-effective manner. On August 18, 1998, representatives of eight institutions signed a Memorandum of Agreement to implement the IEMS. The signatories to the Memorandum of Agreement are: EEAA, 10th of Ramadan CDA, 10th of Ramadan Board of Trustees, 10th of Ramadan Investors Association, the Central Department of Industrial Construction of the Ministry of Industry and Mineral Resources, the Department of Health of the Ministry of Health, the Groundwater Research Institute of the Ministry of Public Works and Water Resources, and the Central Department for Supervising Working Labor of the Ministry of Labor Force and Immigration. The Memorandum identified four major components of the proposed IEMS: organizational, institutional, economic, and information management. Furthermore, it defined the roles and responsibilities of all the institutions that signed the agreement.

Unfortunately, after signing the MOA, few actions were taken to implement the IEMS as there was a funding hiatus until the USAID-GOE EEPP initiated its activities. A review of the IEMS design conducted by USAID in September 1999 indicated that interest remains high among the stakeholders for implementing an environmental management activity, but that initial implementation will require external support. The review also suggested that some components be redesigned to simplify their implementation. Initiation of the implementation of the IEMS is a component of EEPP.

2.1.3 Environment Friendly New Industrial Cities Program

In August 1998, the MSEA launched the Environment Friendly New Industrial Cities program (EFNIC). The objective of the program is to bring new industrial cities into compliance with Law No. 4. During the first phase of EFNIC, the MSEA plans to declare five new industrial cities as environmentally friendly by December 2000. The 10th of Ramadan Industrial City is one of industrial cities targeted for the first phase of the program. For a city to be declared environmentally friendly, it must have at least 90 percent of its industrial plants in compliance with ten environmental criteria including management of hazardous waste. It must also meet seven criteria for the city itself including the development of a central hazardous waste containment facility and management of non-hazardous solid waste.

2.2 Current Hazardous and Non-Hazardous Solid Waste Management

2.2.1 Solid Waste Management Practices and Plans

The 10th of Ramadan CDA is the responsible agency for managing solid waste in the city. In the past, the CDA placed containers in the streets of both the residential and industrial areas and operated a fleet of trucks and equipment to collect solid waste from the containers and transfer it to the public dumpsite. In recent years, the CDA privatized part of its solid waste management activities. It contracted with a private company (Care Services) to collect solid waste from all residential areas and transfer it to the public dumpsite. Under the contract the company also provides street sweeping for the residential and industrial areas, water-spray services for streets, and insecticide-spray for containers.

Care Services collects solid waste from the street-containers in the residential areas and the city’s market. It collects about 140 tonnes of solid waste per day with its 300 workers, five trucks, and two loaders. The amount collected can be as high as 170 tonnes on some days. On its own initiative, Care Services has established contracts with local industries, through which it collects about 20 percent of the non-hazardous solid waste generated by industrial facilities in the city. Recently, Care Service initiated a door-to-door collection service for a fee of 3.00 L.E. per month per apartment. Through this program it is currently providing door-to-door service to about 1,000 apartments.

In addition to Care Services, there are a few small entrepreneurs who collect recyclable waste from industrial facilities and transfer wastes from the facilities to the public dumpsite. Many of the industries transfer their wastes to the public dumpsite using their own trucks. Some of the industries send their drums back to the suppliers for re-filling.

The existing public dumpsite is located six kilometers south to the City on Roubakey Road, which connects the 10th of Ramadan to the Cairo-Suez Road and Badr City. This disposal site has been in use since 1995 and consists solely of a general uncontrolled dumping area where trucks discharge materials at convenient locations or as requested by informal recyclers. Because of this uncontrolled dumping, the disposal area covers an extensive area.

Right-to-access to the dumpsite has been given by the CDA to informal recyclers on a temporary basis. These recyclers operate small enterprises that collect some of the materials that have value (plastic, paper, wood, etc.) and sell them to various markets.

The 10^{th} of Ramadan CDA has started a project to upgrade the dumpsite into a controlled disposal area. The CDA will soon issue a Request for Quotation for two new dumpsites with upgraded standards. The Request was still in preparation in December 1999, so it was not available for the team to review during its mission. The CDA hopes that through the Request it will be able to attract a company to operate the site at no cost to the city.

There are many roads in the 10^{th} of Ramadan that have illegal dumps along them. To solve this problem, the 10^{th} of Ramadan CDA has started two programs. The first is to remove the illegal dumps from the roadways. The CDA allocated 1.2 million L.E. for this purpose. This program started in late 1999 and focuses on the main roads of the heavy-industry areas within the City. The second program is enforcement of the existing ban on illegal dumping. At its November 1999 meeting, the Board of Trustees approved the imposition of fines for illegal dumping. The fines are charged for the area covered by illegal dumps and vary from 20 L.E./m^2/day for building block streets, to 30 L.E./m^2/day for district streets, to 50 L.E./m^2/day for city center streets. The CDA has notified all industrial and commercial facilities in the city that it will begin to enforce these fines in January 2000.

Currently, there is no classification or segregation of hazardous and non-hazardous waste. Hazardous solid wastes are disposed of in the same manner as non-hazardous solid waste. Most of the hazardous solid waste probably ends up at the public dumpsite. The MHCNC has allocated an area of about 190 acres adjacent to the existing public dumpsite for a hazardous and non-hazardous solid waste management facility. Local investors have established a company to undertake environmental development in the city. The company is interested in building and operating a hazardous waste facility, if it is a profitable business.

2.2.2 Solid Waste Management Institutional Capacity

The Cleanliness and Agriculture Section of the Central Department for City Development has the direct responsibility for managing solid waste in the city. This section manages the contract with Clean Services and oversees the public dumpsite. Other CDA departments administer some of the solid waste projects in the city. For instance, the Central Department for Projects administers the program to remove illegal dumps. The Central Department for Implementing Affairs enforces the ban on illegal dumping.

The Environment Section, staffed by two chemists, is also in the Central Department for City Development. It was established in August 1998 to manage the CDA's role in the IEMS as described in the Memorandum of Agreement. In the future, it could be involved in solid waste management, but currently it does not deal with solid waste.

Solid waste management in the 10th of Ramadan is funded by a tax on real estate. CDA collects an annual fee of 0.14 percent of the real estate value of industrial and residential land. This results in an average collection of about 2.50 to 3.00 L.E. per apartment per month and about 1,000 L.E. per factory per year. The income from this fee pays for the city's contract with Care Services.

The City has another local fund called the City Development Fund that is managed by the Board of Trustees. The MHCNC Decree No. 33 of 1995 established this fund. The purpose of the fund is to finance all necessary development needs (services, health, social, etc.) as approved by the Board of Trustees. The financial resources available through the fund are derived from: 1) 0.2 L.E./m^2 fee on industrial, commercial, and services land; 2) 1.0 percent of the sale value of houses, land for housing, and shops; 3) allocations by the Investors Association; 4) donations from city investors and residents; 5) revenues from parties, celebrations, museums, etc.; and 6) any other kind of donations approved by the Board of Trustees for this purpose. The Central Department for Finances and Real Estate administers this fund.

The 10th of Ramadan Board of Trustees in its meeting on March 10, 1998 approved the principal of establishing a local environmental fund to finance environmental activities in the city. This fund was to be created by the IEMS. To date, it has not been created, but it may be a source of funding for solid waste management in the future.

3 Data Needs for Solid Waste Management

Effective planning and implementation of appropriate solid waste management facilities requires sufficient and accurate data by which to quantify solid waste disposal needs. EFNIC has developed an industrial pollution database that contains information on hazardous and non-hazardous solid waste generation in the new industrial cities. The team reviewed the information in the database for the 10^{th} of Ramadan Industrial City. This section of the report identifies the technical data needs for comprehensive hazardous and non-hazardous waste management and presents the team's findings on the EFNIC database.

3.1 Solid Waste Generation Database and Waste Management

Accurate data on both the quantity and type of solid waste generated is essential for the development and management of solid waste programs. Solid waste generation databases are important for a number of reasons including the following:

- The creation of a database increases the general awareness of the quantity and type of solid waste generated in the jurisdiction for which the database is developed and the need for management.

- The database provides critical information to design the size and type of necessary waste collection, transport, storage, treatment, and disposal facilities.

- The database is necessary for assessing financial feasibility, including the calculation of costs, cost recovery, and user fees.

- The database can be used to identify and categorize the different types of wastes, so that adequate management programs can be developed. In addition to classifying wastes as hazardous and non-hazardous, the data base should be able to identify wastes that may be incompatible with each other, wastes that require special handling (such as highly reactive or ignitable wastes), and wastes that require treatment prior to disposal.

- The database can provide the information necessary to develop appropriate health and safety procedures for operation of the waste management system.

Once a database is created, it must be regularly updated through operational monitoring at treatment and disposal sites (truck scale records, etc.) of the amount and type of solid waste received. Updating the database with operational monitoring increases its accuracy, and thus its utility for planning purposes. It also provides a continuous monitor of the generation of solid waste from various sources to help determine and maintain the effectiveness of solid waste management procedures.

3.2 Classification of Hazardous and Non-Hazardous Solid Waste

The collection of data on hazardous and non-hazardous solid waste in Egypt has been hampered by the lack of a national classification system. A critical element in the management of hazardous and non-hazardous solid waste is a clear definition of what constitutes a hazardous waste. In Egypt, the process is still evolving for defining hazardous waste and developing regulations and procedures for managing those wastes. The EEAA, in conjunction with six ministries, is developing a national hazardous waste classification system. The Ministry of Industry and Mineral Resources has prepared a draft document that identifies and lists a number of hazardous wastes that are either specific to a particular industrial sector or common to all sectors (Appendix D). The document, however, has not been finalized.

In the United States, the European Union, and the Basel Convention, hazardous wastes are defined through a number of physical and chemical characteristics such as corrosivity, reactivity, ignitability, and toxicity. In addition, some waste materials are listed as hazardous waste because of their distinctively dangerous properties. Listed wastes do not have to be tested for the physical and chemical properties to be designated as hazardous waste. In case of off-spec and discarded chemicals, the United States' system also includes a list of specific hazardous constituents of industrial chemicals that, if present in the waste stream, make it a hazardous waste. Under all of these systems, if a waste is generated from combined industrial processes, and cannot be accurately identified as a specific listed waste (such as dewatered sludge filter-cake from an industrial wastewater treatment system), the characteristic waste criteria are used to determine if it is a hazardous waste. The use of characteristic waste criteria requires some laboratory tests.

The team recommends that Egypt adopt a hazardous waste classification that defines a waste as hazardous based on either being a ***listed waste*** or a ***characteristic waste***, similar to the approach used in the United States, the Basel Convention, and the system proposed by the Ministry of Industry and Mineral Resources (see Table 1). This approach allows defining hazardous waste relatively quickly based on the listed waste. A comprehensive schedule of listed hazardous wastes from industrial sources can be compiled based on the available lists from the United States' system (Appendix E), the Basel Convention (Appendix F), or other similar classification systems.

Until Egypt adopts a national hazardous waste classification system, the team recommends that EFNIC use the United States' system to classify wastes in its database. The Unites States' system specifies numeric standards for waste characteristics and specific laboratory procedures, which is useful in making determinations about unlisted wastes.

It is important to note that the terms “hazardous and non-hazardous” are relative. Municipal and non-hazardous industrial solid waste will still have properties that can cause environmental damage or pose a danger to public health if not managed properly. In some situations where people or critical environments are located near to waste disposal sites, municipal and non-hazardous industrial solid waste may be very dangerous. For example, fires are common in disposal areas receiving municipal solid waste because of that waste stream’s inherent high combustible content. Smoke from these fires can impact nearby land uses and certainly impact the well being of individuals working at or living near the disposal area.

Insert Table 1

3.3 The EFNIC Program Database

EFNIC is currently collecting data on the quantity and types of hazardous and non-hazardous solid waste generated by industrial facilities in the 10th of Ramadan Industrial City. As of December 13, 1999, the database contained information on 694 industrial facilities in the city. Several of these are small and medium quantity generators of solid waste.

During its mission, the team reviewed the structure and content of the database as it relates to hazardous and non-hazardous solid waste generation. The review was aimed at optimizing the database for use as a practical planning tool for implementation of management processes and facilities. The team concluded that although EFNIC has made a good start at collecting data from industrial facilities, more information is necessary for the design of waste management systems. The following analyses identify means for improving the data in the database so that it can provide an adequate basis for waste management planning and design.

3.3.1 General Solid Waste Data

Generally, the team's review of the database focused on either hazardous or non-hazardous data. The results of those reviews are presented below. However, some issues are common to both the hazardous and non-hazardous components of the database. These issues include classification of industries in the database, the number of fields for reporting types of wastes, special wastes, reporting units, and the design of the information collection. They are addressed in this section.

The industrial classification system currently used in the database is very broad and does not facilitate waste data collection or cross-checking of data between similar facilities. Cross-checking is an important mechanism for maintaining quality control of the database. Periodic cross-checking can identify inconsistencies in types and quantities of waste generated by similar facilities. To facilitate data collection and cross-checking, the team recommends that EFNIC modify the database to include a more comprehensive list of industrial categories as proposed in Table 2. The team also recommends that the database use the International Standard Industrial Classification (ISIC) Codes.

Each particular industry may have a number of components to its overall production waste stream. This could apply to both the hazardous and non-hazardous portions of its waste stream. Currently the database structure allows for only one field each to report the volume and type of hazardous and non-hazardous waste. The structure needs to be expanded to accommodate multiple waste quantities and types for each facility if needed.

Some components of the waste stream constitute special wastes requiring special handling and disposal. These wastes are discussed further in section 4.2.5 of this report. EFNIC needs to define special wastes in consultation with the industries and create a field in the database for recording information on them.

Reporting units within the database need to be standardized. The database currently reports quantities of solid waste by weight and volume units of measurement. Both measures are important, and one may be calculated from the other, but it is inaccurate to apply a single conversion factor to all industrial solid waste because of varying physical characteristics associated with this material. To allow the conversion of units of measurement, the database should provide a link between weight and volumetric quantities by reporting expected unit density for each industrial waste stream.

Table 2
Proposed Industrial Classification System for the EFNIC Database

Type of Industry	ISIC Code	Type of Industry	ISIC Code
Asbestos Products	2695	Basic Metals	27
Building Materials	2696	Iron and Steel	2710
Chemicals & Chemical Products	24	Precious and Non-Ferrous Metals	2720
Basic Industrial Chemicals	2411	Casting of Iron and Steel	2731
Plastic Products	2413	Casting of Non-Ferrous Metals	2732
Pesticides	2421	Glass and Glass Products	2610
Paints	2422	Leather Products	1912
Pharmaceuticals	2423	Metal Finishing	2892
Soaps and Detergents, Cosmetics	2424	Metal Products	28
Other Chemical Products	2429	Structural Metal Products	2811
Dairy Products	1520	Fabricated Metal Products	2899
Electrical Machinery and Apparatus	31	Paper and Paper Products	21
Insulated Cable	3130	Pulp, Paper, and Paperboard	2101
Batteries	3140	Corrugated Paper and Containers	2102
Electronics	3210	Other Paper Products	2109
Food Products and Beverages	15	Printing	2221
Meat and Meat Products	1511	Steel and Iron	2710
Fish and Fish Products	1512	Textiles	17
Fruit and Vegetables	1513	Spinning and Weaving	1711
Oils and Fats	1514	Dying and Finishing	1712
Grain Mill Products	1531	Clothing	1729
Starches and Starch Products	1532	Wood Products	20
Bakery Products	1541	Wooden Containers	2023
Cocoa, and Sugar Confectionery	1543	Other Products (Furniture)	2029
Pasta	1544		

The ability to convert from a weight to volume basis is important for two reasons. First, any consideration of a user pays approach for system funding and cost recovery may include the use of a truck scale at the treatment or disposal site. This will lead to a standardized weight-based determination of waste quantity received from individual industries. Second, an ability to determine the volume of industrial waste received can be important in determining the rate at which landfill capacity, often expressed in cubic meters, will be depleted as waste is received for disposal.

Many anomalies exist in the database, particularly in regard to quantities and types of wastes generated by similar facilities. Some of these anomalies are due to the lack of a hazardous waste classification system, but it is possible that even with a hazardous waste classification system in place, anomalies may exist in the data on quantity and types of waste from different industrial facilities in the same industry. This is often the result of lack of knowledge about specific industrial processes by those collecting the data. This issue can be addressed by two methods: 1) by having a detailed questionnaire specific to each type of industry, and 2) by preparing a process flow diagram for each manufacturing facility with inputs and outputs of key materials and wastes. These two methods will facilitate and organize the data collection activity and make the data more reliable and accurate. They also will aid in future monitoring and updating of the data.

EFNIC should develop the questionnaires and model flow diagrams for the industrial groupings presented in Table 2. EFNIC will need to revise its existing hazardous waste data forms to reflect the more detailed categorization of industries and to solicit more detailed information on the types of wastes generated at each facility, based on the model flow diagrams. Appendices G, H, and I of this report provide information to assist EFNIC in developing questionnaires and flow diagrams. Appendices G and H provide information about and an example of industrial sector notebooks produced by the United States Environmental Protection Agency (USEPA). These notebooks are available on the internet and contain extensive information on waste generation by industrial sector. Appendix I contains an examples of flow diagrams for ten industrial process common in the 10th of Ramadan.

3.3.2 Hazardous Solid Waste

Currently, 67 facilities in the 10th of Ramadan Industrial City have been identified as hazardous waste generators, with a total production of approximately 850 tonnes of hazardous waste per month (Appendix J). Seventeen of the facilities generate at least one tonne of hazardous waste per month (Table 3), representing 99 percent of the total hazardous waste generation. Two companies generate 88 percent of the total hazardous waste: Arabi for Steel, which is reported as generating 500 tonnes per month of iron furnace slag, and Al Ezz Steel, which is reported as generating 250 tonnes per month of iron furnace slag. The next two largest generators of hazardous waste each generate 30 tonnes per month. These four facilities account for 95 percent of the total hazardous waste reported in the database.

The waste reported in the database as hazardous for three of the top four facilities is furnace slag from recycled iron, which may not be a hazardous waste. EFNIC has conducted laboratory analysis of total metal content on the slag from at least one of these facilities and found high levels of cadmium, a toxic substance. However, under the classification system used in the United States, the Toxicity Characteristic Leaching Procedure (TCLP) rather than total metals would be the laboratory test required for determining if a waste contains hazardous substances. The TCLP measures the leachable content of toxic substances in a waste (see 40 CFR Ch.1, Subpart C, paragraph 261.24, in Appendix E of this report). Samples of this waste were tested in the United States using the TCLP. The samples were found to contain levels of cadmium and other toxic metals below the threshold for hazardous waste used in the United States. Thus, this waste would not be classified as hazardous in the United States.

The team identified several anomalies in the quantity and type of hazardous waste reported for facilities in the database. Often, facilities with similar manufacturing processes and production levels had significant differences in the type and quantity of hazardous waste reported in the database. Many facilities producing products that typically generate hazardous wastes are reported in the database as generating no hazardous wastes.

These anomalies exist because of lack of knowledge about hazardous wastes by industry and the EFNIC inspectors who collected the information in the database. Industry and the inspectors do not have a common understanding of what constitutes hazardous wastes. Many of the inspectors also lack a clear understanding of the industrial processes they are inspecting and their potential for hazardous waste generation. This situation is not surprising, particularly since this is the first time that industry and the inspectors have been asked to address hazardous wastes in the 10th of Ramadan Industrial City.

Industries and EFNIC inspectors cannot accurately identify the quantity of hazardous waste generated because a well-defined classification system for hazardous waste does not exist. As discussed above, the GOE needs to adopt a hazardous waste classification system. Until a national system is adopted, EFNIC needs to adopt an interim classification system to

Insert Table 3

guide its data collection efforts. It is very important that all parties involved in data collection, evaluation, and reporting, including the industry personnel, be trained in the use of the interim classification system. This not only will improve the data collection, but it will also create an awareness of hazardous waste that can help ensure that it is safely handled and disposed.

The "type of waste" entries in the database are often not precise enough for adequate hazardous waste planning. In many cases, the type of waste is identified only as generic waste types such as oils, chemicals, containers, sludge, or inks (see Appendix J). It is critical that hazardous waste be classified thoroughly so that chemically incompatible wastes are clearly identified. Inadequate characterization of the hazardous waste can result in major shortcomings in planning and operation of hazardous waste facilities causing fires and explosions due to the combination of incompatible wastes. Once EFNIC adopts an interim hazardous waste classification system, it should use the categories of wastes in the system as the designators for "type of waste" in the database.

After EFNIC modifies the database structure, adopts a classification system, develops detailed questionnaires and flow diagrams, and trains its staff, it will need to revisit the facilities with the greatest potential for hazardous waste generation and collect more detailed information. Once accuracy and thoroughness has been achieved, the information contained in the database can be used in planning of the new facilities that will comprise the integrated solid waste management program for the 10th of Ramadan. The database information will define the amount and type of solid waste that must be managed, which will help to determine required design capacity and projected life expectancy of disposal facilities.

3.3.3 Non-Hazardous Solid Waste

Industrial sources also generate non-hazardous solid waste, including production waste that may not have the dangerous properties that would lead to its classification as a hazardous waste. Industrial non-hazardous waste may also include office waste (paper, etc.) and other solid waste (food waste, etc.) associated with the workers at the industrial plant. This non-production waste stream will have general properties similar to that of municipal solid waste generated by full time residents of the City.

The current EFNIC database[1] indicates that approximately 15,000 tonnes per month of non-hazardous waste is generated by 497 industrial facilities in the 10th of Ramadan Industrial City. The top 30 generators generate about 90 percent of this waste (Table 4). Four of the top 30 generators produce over 1,000 tonnes per month, accounting for 43 percent of the total waste generated.

The non-hazardous solid waste component of the database must provide sufficient and accurate information for determining required disposal capacity for this type of industrial waste. It should also provide information for evaluating the current extent and potential for waste reduction through source reduction, waste exchange and recycling. Further refinement of the non-hazardous waste data is required if the information is to be successfully used in planning. This refinement must include a clear definition of hazardous wastes, more detailed

[1] The database delivered to the team by EFNIC on December 13, 1999.

Insert Table 4, Page 1

Insert Table 4, Page 2

information on current disposition of wastes, and identification of non-process solid waste generation.

A critical need for the non-hazardous waste database is the adoption of a hazardous waste classification system. The adoption and use of a hazardous waste classification system will, by default, define the non-hazardous portion of the total solid waste stream. If the hazardous and non-hazardous solid waste streams are to be managed independently, there needs to be a clear determination that all hazardous solid waste at the 10th of Ramadan industries is accounted for based on the adopted classification system. The definition is also important in helping to assure that higher cost hazardous waste disposal capacity is not used for disposal of non-hazardous wastes, thereby increasing the overall cost of waste disposal and depleting the capacity of the facility more rapidly than anticipated.

The database needs to be able to better collect and report upon the means of disposal for non-hazardous waste. Many of the industries reported in the database that their non-hazardous production waste is "sold". Does this determination mean that ***all*** non-hazardous production waste is sold? The database should be extended to determine what proportion of the non-hazardous production waste is sold and what proportion is ultimately transported to the disposal area. Additionally, information should be collected on the markets for their waste materials. Are the markets other industries within the 10th of Ramadan Industrial City or are they other commercial markets interested in the material because of its particular composition? Information on markets will be invaluable in future efforts to increase recycling and waste exchange.

Many of the industries in the database indicated their disposal method as "safe". The database needs to provide greater definition to this term. Does the term include materials that are sold or recycled? Does the term refer solely to transport of the material to the existing disposal area that they perceive to be "safe"?

Solid waste derived from offices or workers at the 10th of Ramadan industries is an important element in the non-hazardous solid waste stream. If the quantities of non-hazardous solid waste reported in the database are solely based on production waste, the information should be enhanced by requesting a breakdown of the non-hazardous waste stream derived from the industry into 1) production and 2) office- and worker-related waste. If an assessment of the office- and worker-related solid waste is not available, the interviewer should request an indication of the total number of full-time and part-time workers employed at the industry. This information can be used to generate an estimate of the quantity of non-production waste generated at the facility.

3.4 Data Collection Dynamics

Planning is required for any industrial interview process. Interviewers need to understand the basis for the questions that they are asking and be able to assess and interpret the answers and information that they are receiving. This requires that interviewers have a basic understanding of the production and waste generation process in each particular industry or category of industries. Given the variety of industries in the 10th of Ramadan and the other new industrial cities, it is unrealistic to expect EFNIC inspectors to have specialized knowledge for each type of industry they inspect. To the extent possible, then, EFNIC should assign inspectors to an industrial category or group of categories so that a focus can be created on the specific characteristics of their industries in preparing for the data gathering process. Increased knowledge on the part of EFNIC inspectors of specific industrial processes will allow them to pose appropriate questions to similar industrial facilities that may have reported significantly different types and volumes of solid waste. This cross-checking approach will apply to both the hazardous and non-hazardous components of the waste stream database.

Future work in defining the types and volumes of non-hazardous industrial solid waste to be managed at upgraded disposal sites should focus on high generation industries. These industries will have a major impact on the required capacity of the solid waste management system and, particularly, the disposal component.

3.5 Municipal Solid Waste

The non-hazardous waste stream consists of two principal components: municipal solid waste generated by full-time residents of the city and non-hazardous industrial waste generated at the industries within the city. Other waste streams, such as the solid waste generated at markets or through building construction and demolition, are also part of the total waste stream but may have properties that allow independent management. Market waste, for example, may be an excellent material for development of good quality compost that can be used for agricultural or horticultural applications.

The EFNIC database contains only data on non-hazardous industrial waste generated by the industries. To design a non-hazardous waste management system, the city will also need data on municipal solid waste. This section of the report provides a preliminary estimate of the municipal solid waste component of total non-hazardous waste generated in the 10^{th} of Ramadan.

The full-time residents of the 10th of Ramadan Industrial City generate municipal solid waste. The amount of municipal solid waste generated in the 10^{th} of Ramadan is a function of a number of factors including:

- Total population,
- Unit waste generation rate,
- Proportion of waste collected for disposal, and
- The effectiveness of formal and informal recycling and compost programs.

The current full-time population of the 10^{th} of Ramadan Industrial City is approximately 50,000 people. Table 5 presents an estimate of the amount of municipal solid waste generated by the full time population of the municipality. In Table 5, an estimated collection efficiency of 75 percent was used to calculate the amount of municipal solid waste actually reaching the disposal site. Based on Table 5, approximately 20 tonnes per day of municipal solid waste are transported to the disposal area. Based on an estimated population growth of 2 percent per year, the municipal solid waste that must be handled at the disposal area will grow with time as illustrated in Figure 1.

Insert Table 5

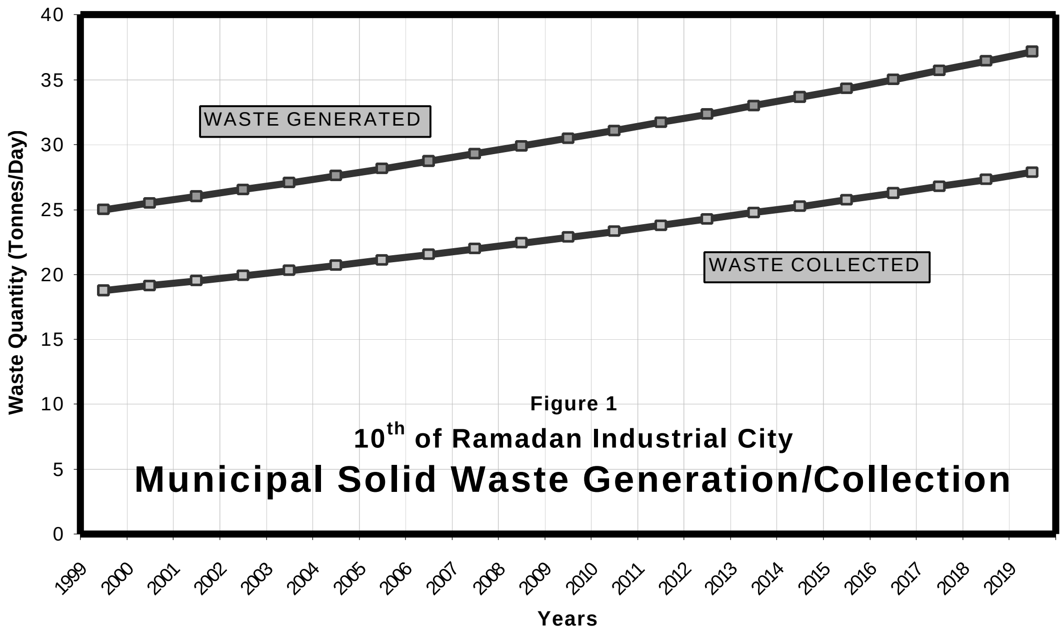

Figure 1

10th of Ramadan Industrial City

Municipal Solid Waste Generation/Collection

While increases in municipal solid waste generation are expected with general increases in population, there are several factors that have a significant effect in the future population of the 10th of Ramadan and other industrial cities in Egypt. These include the following:

- As the number of industries in each new industrial city increases, more jobs are created which can serve as an important stimulus to growth of full-time population within the city. As a result, the population increase experienced in the industrial cities may partially be a function of countrywide economics that influence industrial development. The current projection of future industrial development in the 10th of Ramadan forecasts about 1,500 industries by the year 2017.

- If more land is dedicated to residential use in the industrial cities, this may lead to construction of additional residential units. The population in an industrial city may increase simply because of the attractiveness of living in the industrial city area. This appears to be the case in the 6th of October Industrial City where the full time population is considerably higher (about 250,000 versus 50,000) than that in the 10th of Ramadan.

4 Target Standards

A primary objective of this report is to provide comments to the GOE on the proposed hazardous waste landfill for the 10th of Ramadan Industrial City. This section of the report presents the standards against which the proposed landfill can be assessed.

Effective solid waste management is defined by meeting standards that assure management practices and facilities are environmentally sound and sustainable. In many countries, rigid and well-defined standards exist that clearly delineate the design criteria for hazardous and non-hazardous solid waste management and facilities. These standards also define operational procedures that must be followed to assure that the defined standards are successfully sustained.

Work is progressing in Egypt to establish standards that will require all hazardous waste generators and managers to fulfill the intent of Law No. 4 of 1994. But the standards have not been fully promulgated. Therefore, this section presents general standards for hazardous and non-hazardous waste management against which any proposed management system can be measured. The information in this section can also provide guidance for the development of facility standards and for the design and implementation of waste management systems.

4.1 Hazardous Waste Treatment, Storage, and Disposal Facility Standards

A landfill is one component of a hazardous waste treatment, storage, and disposal facility (TSDF). A TSDF is an integrated hazardous waste management facility that includes units for receiving, storing, treating, and disposing of hazardous waste. The standards for a TSDF consist of technical elements for design and construction as well as management elements for operation. Some of the key elements are as follows:

General Facility Standards - The general facility standards describe the administrative conditions and requirements to own and operate a TSDF. They include permit requirements, preparation of waste analysis plans, data on quantity and type of wastes, analytical data on waste, inspection requirements, training requirements, and general requirements for handling ignitable, reactive, and incompatible wastes.

Manifest System, Record Keeping, and Reporting - These standards specify the requirements for use of a manifest system to track hazardous waste from the point of generation to the point of disposal. They include detailed requirements for record keeping and reporting to responsible authorities.

Preparedness and Prevention - These standards specify the requirements for the design, construction, and operation of the facility to prevent and minimize the possibility of a fire, explosion, or any unplanned releases of hazardous waste constituents to air, soil, surface water, and groundwater which could affect human health or the environment. The standards generally include requirements for: containment; detection; alarms; communication; fire protection; spill prevention, control and decontamination; access requirements for emergency vehicular traffic; and testing and maintenance of equipment;

Contingency Plan and Emergency Procedures - These standards specify the requirements for preparing a contingency plan for the facility. The objective of a contingency plan is to minimize hazards to human health and the environment in case of a fire, explosion, and sudden release of hazardous constituents into the air, soil, surface water, or groundwater. The standards include requirements for: procedures for personnel to respond to a sudden release situation, emergency response equipment, safety measures, evacuation procedures, and arrangements with local fire, emergency response, and medical authorities.

Releases from Hazardous Management Units - The purpose of these standards is to define the requirements for detecting, characterizing, and responding to releases of hazardous constituents into the environment. These standards include requirements for: locating and installing monitoring wells, conducting soil borings (if necessary), chemical characterization of soil and water samples, and developing corrective actions necessary to remediate the contamination and prevent reoccurrence of the release. It also includes standards for maximum concentration of constituents permitted in groundwater; routine groundwater monitoring procedures, analysis, and detection; and compliance reporting for hazardous waste management facilities.

Closure and Post-Closure - These standards include requirements for closure of a hazardous waste facility in a manner that: a) minimizes post-closure escape of hazardous constituents to air, soil, surface water, and groundwater which could affect human health or the environment, and b) minimizes the need for further maintenance. The standards also include periodic monitoring requirements for groundwater contamination via sampling and analysis of monitoring wells and inspection of the facility for potential releases.

4.2 Hazardous Waste Landfill Standards

Typically, the general TSDF standards for preparedness and prevention and closure and post-closure include specific standards for hazardous waste landfills and other waste management units such as container storage, tank systems, surface impoundments, waste piles, and incinerators. These standards describe the requirements for design, construction, and operation of the specific management units.

Various designs and configurations have been used for the development of hazardous waste landfills. Specific standards depend upon the risks posed by the disposal facility as well as the attitude of the jurisdiction issuing the standards about those risks. For that reason, it is not possible to present a generic set of standards that apply to all hazardous waste landfills; however, at a minimum, the design of a hazardous waste landfill should address the following elements:

Liner,
Leachate collection, treatment, and disposal system,
Groundwater monitoring wells,
Gas collection system,
Special waste handling,

Access roads and controlled access point,
Administrative, security and maintenance structures and landscaping
Utilities, lighting and fencing,
Cover system, and
Operations plan.

Many of these elements are applicable to the disposal of non-hazardous solid waste as well; however, for non-hazardous waste landfills the standards for liners and leachate collection systems may be less stringent, depending on the risks associated with protecting groundwater resources at the landfill site. The following sections provide the general design basis for key components that would be expected to be a feature of a hazardous waste landfill in the 10th of Ramadan.

4.2.1 Liner

A liner is a hydraulic barrier that prevents or greatly restricts migration of liquids from the landfill into the surrounding soil. An effective liner is required to prevent migration of pollutants to offsite receptors (humans and critical environments), primarily through groundwater contamination.

Liner systems in landfills are composed of flexible materials to allow for uneven loading and settlement due to waste disposal. Typical liner systems generally consist of a series of layers of different material. The bottom layer over the natural soil is usually a compacted clay layer with permeability of less than 10^{-7} cm/sec. One or more flexible membrane liners (FML), generally composed of high-density polyethylene with a thickness of 40 to 80 mils[2], often overlies this layer.

The actual design of a liner should be a function of the risks associated with potential pollutant migration into the underlying soil and groundwater at any particular site. It should be based on careful consideration of factors such as the type of waste, site conditions, leachate generation, risk to public health and environment, and cost. In areas where conditions are arid and groundwater is located sufficiently deep, the standards for a liner system may be less stringent compared to areas with higher rainfall and humidity, and shallower groundwater aquifers. In addition, the permeability of the underlying soil is an important consideration. Sandy soils, such as in Egypt, have high permeability, and therefore increase the potential for migration of leachate in the underlying soil.

Alternative configurations that may be appropriate for the 10th of Ramadan disposal facility are discussed in Appendix K of this report. Appendix K is Chapter 7B, "Designing and Installing Liners: Technical Considerations for Surface Impoundments, Landfills and Waste Piles," of the Guide for Industrial Waste Management.[3] A copy of the complete Guide is being transmitted with this report as a separate document.

---

[2] A mil is one one-thousandth of an inch.
[3] USEPA. 1999. Guide for Industrial Waste Management. Draft Document. OSWER, USEPA, Washington, DC. Draft available on the internet at: http://www.epa.gov/epaoswer/non-hw/industd/guide/index.htm.

4.2.2 Leachate Collection, Treatment, and Disposal System

An effective liner prevents the migration of leachate to soils under the landfill. It also allows the collection of the leachate for controlled treatment and disposal. The leachate collection system must provide for the continual removal of leachate from the top of the liner. If a hydraulic head of leachate is allowed to build on top of the liner, there is a greater potential for leakage as a result of increased hydraulic pressure on the liner.

A leachate collection system consists of a drainage layer of sand with a permeability of at least 10^{-4} cm/sec located on top of the upper most liner. Perforated pipes are installed in the drainage layer to collect and remove the leachate. In cases where the health and environmental risks associated with leachate migration into the groundwater are high, a second leachate collection system may be installed between liners. Thus, if the first liner fails, the second liner, and associated leachate collection system, will prevent leachate migration. This interstitial configuration also provides a mechanism for liner leak detection.

Once leachate is collected, it must be treated and disposed of in a manner that prevents environmental damage. In arid locations, leachate treatment and disposal through evaporation ponds is often practical. Design considerations for leachate collection, treatment, and disposal systems are presented in Appendix K.

4.2.3 Groundwater Monitoring Wells

Groundwater monitoring wells provide a basis for monitoring the environmental performance of a landfill. The locations and number of monitoring wells will be a function of site hydrogeology and the degree of environmental protection (liners, etc.) provided. Design considerations for groundwater monitoring wells are presented in the Guide for Industrial Waste Management, which is being transmitted with this report as a separate document.

4.2.4 Gas Collection System

The primary purpose of a gas collection system is to vent gas that may be generated so as to minimize the potential of fire and damage to the landfill. The potential for gas generation is a factor of waste types and site characteristics. Detailed information on the types and volumes of wastes is necessary to evaluate the need for a gas collection system.

4.2.5 Special Waste Handling

Many hazardous waste landfills include designated areas for the management of special waste. Special waste is waste that exists in such an unusual quantity or in such a chemical or physical state that it may disrupt or impair effective waste management or threaten public health, human safety, transportation, or disposal procedures.

An example of a typical special waste is asbestos or asbestos containing materials. While this material does not fit many conventional hazardous waste classification definitions, it requires special handling so that disposal area workers are not exposed to potential asbestos fiber inhalation. Once placed in a landfill, this form of material must be covered immediately and should not be disturbed through excavation or any other activity that could lead to fiber release. This isolation requirement often leads to dedicated locations where this type of materials is placed.

A listing of waste requiring special handling should be developed in the preparation of the landfill operations plan (section 4.2.10). The plan should also prescribe all of the procedures required to safely handle special waste.

4.2.6 Access Roads and Controlled Access Point

Waste delivery vehicles must typically travel over landfill access roads leading to the disposal location once they leave public roads. Landfill access roads have to be sufficiently designed and maintained to allow easy access. Deteriorated access roads can lead to increased maintenance requirements for delivery vehicles. Poorly maintained access roads, by restricting easy access to the site, can also increase uncontrolled dumping along the sides of the road.

Effective management of a landfill requires that access be limited to locations where landfill staff can determine the classification of the delivered material and direct it to the appropriate area. The controlled access point should be equipped with gates so that traffic into the disposal site can be restricted to the operating hours of the landfill.

4.2.7 Administrative, Security and Maintenance Structures and Landscaping

In an effective landfill, buildings should be provided for administrative, security and maintenance functions. While conventional in design, placement of the buildings needs to be integrated with the overall landfill configuration and design. Properly designed and operated landfills should also be landscaped at strategic locations to reinforce the notion that the facility is more than an uncontrolled dumping area and that effective controls are in place.

4.2.8 Utilities, Lighting, and Fencing

Utilities should be provided for operation of the landfill. These should include electrical power for the buildings and for other electrically driven mechanical devices such as leachate pumps and security lighting. Lighting should be installed at the controlled access point and at any other locations where nighttime activities occur. A hazardous waste landfill should be fenced so as to restrict access. Scavengers must not be allowed to come into contact with hazardous waste because of the danger associated with that contact.

4.2.9 Cover System

The design should include provisions for final cover of each cell in the landfill. The final cover is applied to each cell as it is filled. The purposes of the cover system are to:

1. Prevent direct contact of people with the hazardous waste,

2. Minimize infiltration of precipitation which may cause increased leachate generation,

3. Prevent contaminated run-off from the landfill,

4. Minimize wind erosion, and

5. Minimize soil erosion and slope failure of the landfill.

4.2.10 Operations Plan

The landfill operations plan describes how the landfill will be managed to ensure that material is received, handled, and disposed of so as to ensure proper tracking of waste, prevention releases to the environment, and prevent exposure of landfill workers to dangerous substances. The operations plan should include procedures for weighing or otherwise accounting for wastes received, maintaining records, producing reports to government agencies as required, conducting necessary chemical analyses and monitoring, on-site handling and periodic covering of wastes, and handling of special waste. The operations plan should also contain contingency plan for emergencies.

The inherent dangerous properties of hazardous waste require that the individuals who handle the material be properly trained and equipped. The operations plan should include a training program for landfill employees so they can recognize the various properties of the hazardous waste that comes to the facility and handle and dispose of it in a safe manner.

A sample outline for a landfill operations plan is presented in Appendix L. The amount of waste to be disposed of at a facility directly affects the level of resources that must be applied to handle the material. Many of the elements shown in Appendix L are defined by the quantity of waste placed in the landfill. As the quantity of solid waste to be managed increases, the level of resources (mechanized equipment, personnel, etc.) will also increase.

4.3 Basis for Landfill Design

Design requirements for a hazardous waste landfill are often a function of the risk that disposal of the wastes poses to human health and the environment. Logically, the greater the risk, the greater the need for leak prevention and detection such as liners and interstitial leachate collection. Potential risks are a function of several factors including: climatic and hydrogeologic conditions, the type of waste to be disposed, and existing and adjacent land use.

4.3.1 Climatic and Hydrogeologic Conditions

The climatic and hydrogeologic characteristics of any proposed landfill site are important in defining the design criteria and operational procedures required for effective and safe disposal. Climatic conditions such as rainfall and evaporation can greatly effect the creation of leachate and movement of hazardous substances away from the point of disposal.

Areas with low rainfall and high evaporation present less risk of externally generated leachate than areas with high rainfall and low evaporation. For example, the average rainfall over Egypt as a whole is only 10 mm/year while evaporation rates are high, about 3,000 mm/year. This will minimize leachate production and, as a result, pollutant mobility from landfills. Leachate, however, will still be generated as a result of the inherent moisture contained in some solid waste streams (sludge, etc.). While the quantity of leachate may be low, its pollutant loading is apt to be high because of a lack of dilution that would be created through rainfall or surface water contact.

The vulnerability of groundwater is based also on a number of hydrogeologic factors including: 1) the leaching capacity of the upper soils, 2) the depth of groundwater, and 3) the groundwater flow direction. At solid waste disposal sites, the leaching capacity of the upper soils and the depth to groundwater determine the natural attenuation of the leachate. Natural attenuation is a term given to the natural chemical or physical treatment processes that pollutants are exposed to as leachate flows through soil. Low permeability soils, such as silt or clay, will impart greater attenuation than high permeability soils, such as sand and gravel. Chemical composition of soils also affects their natural attenuation. Additional detail on the processes through which natural attenuation occurs is presented in Chapter 7A of the USEPA's Guide for Industrial Waste Management, which is being transmitted with this report as a separate document.

Depth to groundwater directly relates to the length of time that pollutants are in contact with attenuating soils in the unsaturated zone. Once pollutants reach the groundwater, the attenuation processes continue but are generally not as effective as during the time that leachate is flowing through the unsaturated zone above the groundwater table.

Groundwater flow direction is important in determining the potential for transport of pollutants to nearby, down gradient receptors, such as wells and springs. The potential health effect of pollutants is decreased if flow of groundwater that has come into contact with contaminants is away from potential receptor sites. Similarly, the natural dispersion of pollutants in groundwater flow usually decreases the concentration of the pollutant as it travels away from the point of origin. This emphasizes the importance of the distance from pollution sources to potential receptor contact sites such as wells and springs.

4.3.2 Type of Waste to be Disposed

The type of waste determines its toxicity. It also determines the persistence of the pollutants if they are released to the environment. As discussed throughout this report, there are differences between materials that are classified as hazardous and non-hazardous waste. The physical and chemical differences between these waste streams generally lead to different standards of design and operation. Since there is a greater element of risk associated with materials that are classified as hazardous waste, more stringent standards are justified. Because of this, design features such as liners may be different in a hazardous landfill design than would be the case in a non-hazardous waste landfill.

4.3.3 Existing and Adjacent Land Use

Existing and adjacent land greatly affects the risks posed by waste management. Risks to health and environment are determined by the toxicity of a pollutant, its potential for release to the environment, its ability to be transported to receptors, and the availability of receptors. Existing and adjacent land use is the primary determinant of availability of receptors. Generally, the further an activity is removed from critical environments or areas where humans live or congregate, the less the impact of that activity will have on health and the environment.

4.4 Design Process for Landfill Development

The following design process work tasks are those conventionally used for the design of hazardous and non-hazardous landfill facilities. Since a site adjacent to the current disposal area has been designated for the 10th of Ramadan hazardous waste landfill, the following description does not include site selection activities aimed at evaluating a number of alternative sites and selecting a best location for the new landfill.

4.4.1 Design Activity 1 – Develop Information and Evaluations

In developing a new landfill, there are a number of technical evaluations that are necessary to generate sufficient information for design. This may include surveys and testing aimed at defining the physical and environmental characteristics of the proposed site. These data generation and evaluation activities include the following:

Hydrogeologic Evaluation – The hydrogeologic evaluation is intended to define the characteristics of subsurface conditions beneath the landfill. Of particular interest is the depth to groundwater, its direction of flow, groundwater quality, and status as a useable groundwater or aquifer resource. A site-specific hydrogeologic evaluation provides the basic data for an assessment of migration of pollutants and potential for contact with humans and critical environments. Using this assessment, a liner design can be selected on the basis of the amount of environmental risk the responsible agency is willing to take in implementing the landfill.

Topographical Survey **–** A topographical survey provides a definition of surface conditions that will define the landfill and cell configuration. The extent of slopes on the site as well as the location of natural features will affect the landfill design and configuration. Topographical relationships can also affect the waste disposal capacity that can be designed into a controlled landfill on a particular site.

Resource Inventory **–** A resource inventory provides information on the availability of nearby materials that may be required for the construction and operation of the landfill. Such resources include soil to be used as intermediate and final cover, clay for liners, and sand for drainage and leachate collection systems. The availability of these resources can influence the design of the landfill.

4.4.2 Design Activity 2 – Preliminary Design Evaluation

After completing the information and evaluation tasks, preliminary design of the landfill can commence. The preliminary design evaluation will develop the spatial relationships for the landfill as well as establishing initial sizing for plan development. The following is a listing of specific tasks that should be accomplished in this preliminary design activity.

1. Select landfilling method based on:
   a. Site topography
   b. Site soils
   c. Site groundwater

2. Specify design dimensions
   a. Cell width, depth, length
   b. Cell configuration
   c. Fill depth
   d. Liner configuration and thickness
   e. Interim cover soil thickness
   f. Final cover and final land use specifications

3. Specify operational features
   a. Use of cover soil
   b. Method of cover application
   c. Equipment requirements
   d. Personnel requirements

4.4.3 Design Activity 3 – Prepare Design Package

The design package contains the information necessary for construction of the landfill. This design activity also generates the information for environmental impact analysis and permitting, if required. The following are specific work tasks and outputs from this activity.

1. Develop preliminary site plan of fill areas

2. Develop landfill contour plans
   a. Excavation plans (including benches)
   b. Sequential fill plans
   c. Completed fill plans
   d. Fire, litter, vector, odor and noise controls

3. Compute solid waste storage volume, soil requirement volumes, and site life

4. Develop final site plan showing:
   a. Normal fill areas
   b. Special working areas
   c. Leachate controls
   d. Access roads
   e. Structures
   f. Utilities
   g. Fencing

    h. Lighting
    i. Monitoring wells
    j. Landscaping

5. Prepare elevation plans with cross-sections of:
    a. Excavated fill
    b. Completed fill
    c. Phase development of fill at interim points

6. Prepare construction details and specifications
    a. Liner system
    b. Leachate controls
    c. Access roads
    d. Truck scale
    e. Structures
    f. Monitoring wells

7. Prepare ultimate closure and land use plan
8. Prepare cost estimate
9. Prepare design report and specifications
10. Prepare environmental impact assessment
11. Secure site assignment, if necessary

4.4.4 Design Activity 4 – Prepare Facility Operations Plan

In the final design activity, the operations plan is developed. Unless required for project review prior to construction, this design activity can occur simultaneously with construction. However, it should be completed prior to commencement of operations so that all operations are governed by the content of the operations plan. The operations plan is an integral part of assuring that the design intent will be met in actual operations. It also assures that all required resources necessary to meet the design intent are defined. An example outline for a landfill operations plan is shown in Appendix L.

4.5 Non-hazardous Solid Waste Management System

Based on experience in other countries, non-hazardous solid waste management using appropriate technologies has been proven to be cost effective and can effectively protect the environment and public health. Integrated management of non-hazardous solid waste is normally made up of the following elements:

- ***Source Reduction*** – Municipal and industrial generators are often able to decrease the amount of solid waste that they generate through increased efficiency or through source reuse of materials that have historically been sent to disposal areas as solid waste. Generally, industry has led the way in evaluating their waste management practices through pollution prevention and cost recovery norms to assure that actual waste quantities shipped to disposal areas are kept at a minimum. Experience in programs such as USEPA's Enviroene and Wastewise can provide information on what has been accomplished in industries similar to those in the 10th of Ramadan to reduce waste generation and disposal costs.

Typically, the economic incentive to minimize waste production grows as the cost of solid waste transport and disposal increases. This is an extremely important aspect in implementing effective solid waste management since easy disposal in low or no cost substandard disposal areas, such as the current 10th of Ramadan disposal area, reduces the incentive for source reduction.

- ***Recycling*** **–** The recovery and sale or reuse of materials with intrinsic value is an important element in decreasing the amount of solid waste requiring disposal. This process is the basis for existing informal recycling activities at the current 10th of Ramadan dumpsite. In the future, the process of recycling in new industrial cities may be formalized since there may be industries within the cities that can make use of waste components recycled from municipal and industrial waste streams. Formal recycling programs are normally driven by the market value of recovered material or by the economic and environmental benefits of reducing the amount of solid waste requiring disposal. Generally, as the design and operating standards for disposal facilities evolve, the costs associated with the facilities increase, creating greater incentives for recycling and composting (a form of recycling).

- ***Collection and Disposal*** – Even the most effective source reduction and recycling programs will not eliminate the need for environmentally sound disposal facilities. Therefore, solid waste management requires systems for collection and disposal of solid waste. The most common form of disposal for non-hazardous waste is sanitary landfill.

4.6 Non-Hazardous Waste Landfill Standards

While the dangers inherent to municipal and non-hazardous industrial solid waste are not expected to be as great as those associated with hazardous waste, they can still cause significant damage to the environment and affect public health. Therefore, proper care must be taken in both the design and operation of facilities that manage non-hazardous solid waste so as to control movement of pollutants and mitigate the risks associated with them.

4.6.1 Design

The design requirements for a non-hazardous waste landfill are generally the same as those for a hazardous waste landfill, with the exception of the liner requirements. In many countries, landfills for municipal and non-hazardous industrial solid waste are constructed with liners and leachate collection systems to prevent pollutants from migrating to surface water or groundwater. If justified through analysis of the risk associated with not having them, liners and leachate collection systems are constructed in the same manner as those constructed for hazardous waste landfills. However, the liner configuration may be less stringent. For example, a new or expanded municipal solid waste landfill in the United States is generally required to have a composite liner constructed of a FML over compacted clay. A hazardous waste landfill, on the other hand, is generally required to be constructed with a double or double composite liner because of the additional environmental risk associated with hazardous waste disposal. In either case, the components of the liner configuration (FML, compacted clay, and leachate collection, treatment, and disposal system) would be constructed in a similar manner with stringent control of material specifications and installation quality.

4.6.2 Operations

All of the elements contained in the sample outline of a landfill operations plan presented in Appendix L apply to a landfill dedicated to non-hazardous waste disposal as well as to one receiving hazardous waste. Similar to design considerations, the inherent lower health risk associated with the management of non-hazardous waste would warrant less stringent operational requirements that would be reflected in the individual elements of the operations plan.

5 Comments on Proposed Design for a Hazardous Waste Landfill

A preliminary design for a hazardous waste landfill to serve the 10th of Ramadan industries was prepared by Misr Consult. The team reviewed the design. This section of the report presents the teams' comments on the design.

5.1 Integrated Solid Waste Management

Although the focus of this section of the report is on the proposed hazardous waste landfill, the 10th of Ramadan Industrial City ultimately needs to develop an integrated solid waste management system. Effective solid waste management is an integrated process involving a number of distinct elements including collection, storage, transportation, treatment, and disposal. The objective of an integrated solid waste management system is to reduce the impact of solid waste on human health and the environment. The best way to reduce the impact is to reduce the amount of waste managed by the system, so a basic intent of an integrated solid waste management system is to safely reduce the amount of solid waste requiring disposal in environmentally sound landfills. This reduction is achieved through source reduction or the recovery and reuse of materials prior to disposal.

While care needs to be taken in the management of all solid wastes, greater care is warranted for the management of hazardous waste. Design, operational, and regulatory standards for hazardous waste should be more stringent than the standards for non-hazardous waste. Since more stringent requirements will increase the cost of management, there are economic and technical justifications to manage hazardous and non-hazardous waste streams independently.

For effective management, the criteria for identifying and classifying hazardous waste should create a distinct planning/evaluation line so that these waste streams can be kept separate throughout the 10th of Ramadan's integrated solid waste management system. This separation and independent management is illustrated in Figure 2 where hazardous solid waste is managed generally independent of non-hazardous industrial and municipal solid waste. This separation should include all aspects of the solid waste management system including collection, storage, transportation, treatment and disposal.

While integrated in planning, and in some cases administration, the specific systems and facilities designed for hazardous and non-hazardous solid waste streams may be physically different and can be developed independently and at different times as illustrated in Figure 2. Independent development allows higher priority components (such as a hazardous waste landfill) to be developed first with the ultimate goal of eventually developing the other elements that are required for fully integrated management. This approach has been proposed in the 10th of Ramadan Industrial City where the first component to be developed is a hazardous waste landfill followed eventually by the implementation of upgraded non-hazardous waste processes. Typically, a hazardous waste disposal facility would include some additional process units such as chemical stabilization or incineration of sludge and liquid hazardous waste. However, the initial focus on a hazardous waste landfill alone provides for an extremely important function -- the separation of the industrial hazardous waste stream from that which is non-hazardous.

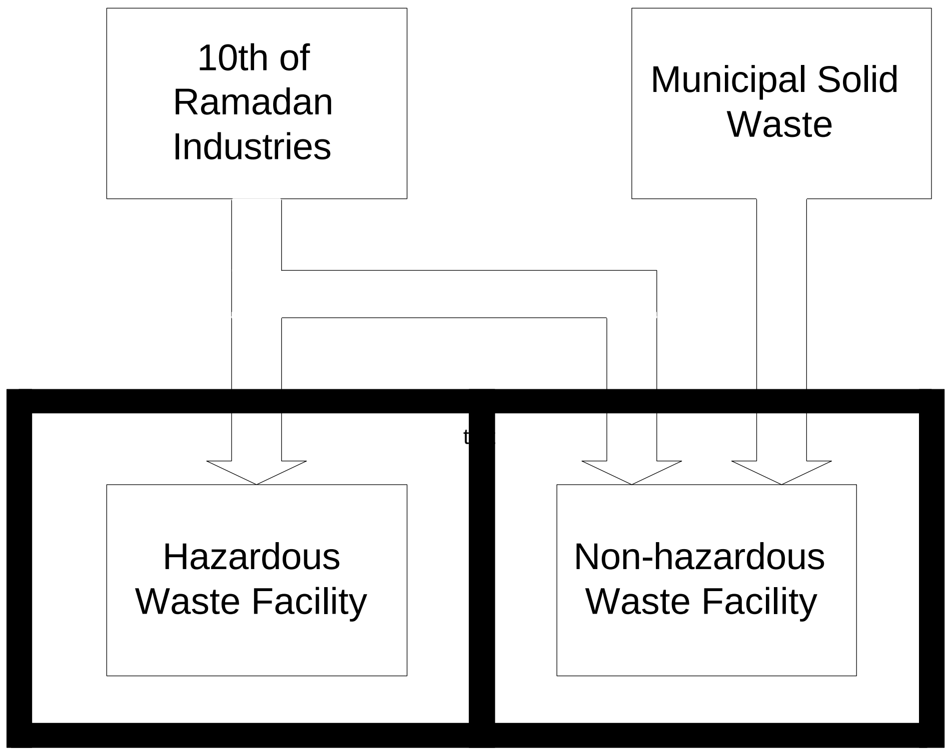

Figure 2
INTEGRATED SOLID WASE MANAGEMENT SYSTEM

5.2 Technical Evaluation

5.2.1 Site Considerations

In 1997, the Research Institute for Groundwater of the National Water Research Center in the Ministry of Public Works and Water Resources completed a general assessment of groundwater pollution in the area of the 10th of Ramadan Industrial City[4]. While this study focused on the effect of wastewater disposal from industries within the city, there are a

[4] The Research Institute for Groundwater. 1997. Assessment of Groundwater Pollution in the Tenth of Ramadan City, Final Report. The National Water Research Center, Ministry of Public Works and Water Resources, Cairo.

number of observations in the assessment that are relevant to the groundwater conditions beneath the existing disposal area and the site of the proposed hazardous waste landfill. Key observations from the groundwater assessment are as follows:

- The 10th of Ramadan is located near the border of two aquifer systems: 1) the Nile Valley and Delta aquifer system and 2) the karstified Carbonate aquifer system. Figure 22 in the groundwater assessment shows that the depth to groundwater is more than 80 meters in the general area of the disposal site.

- Figure 23 in the groundwater assessment shows that the current disposal area is located in an area of low groundwater vulnerability. The assessment based vulnerability of groundwater on three factors: leaching capacity of soils in the unsaturated zone, depth to groundwater, and groundwater flow direction.

The general area in which the proposed hazardous waste landfill is to be constructed has been used as a disposal area for 5 years. There are no residential areas near the disposal site. This is important in defining the risks associated with the landfill. Risks are defined by the relationship of hazards to potential receptors. Based on the initial observations of the team, the primary risk associated with the current landfill operation is direct contact with materials by the informal recyclers who work at the disposal area. This risk is enhanced by the fact that most of the hazardous waste from the 10th of Ramadan industries is currently dumped at the disposal site along with the non-hazardous waste. If hazardous wastes are segregated from non-hazardous wastes and recyclers are prohibited from scavenging at the hazardous waste site, then current risks would be reduced.

5.2.2 Design Considerations

The preliminary design for the hazardous waste landfill proposed for the 10th of Ramadan Industrial City has many of the components necessary for a hazardous waste landfill including a liner; access road and controlled access point; administrative, security and maintenance structures and landscaping; and utilities, lighting, and fencing. However, many other components are not present in the design, including leachate collection, treatment and disposal; groundwater monitoring; gas collection; and a cover system. Although the design does include a liner, the specification for the liner may be problematic. The team has the following specific comments on the design.

1. The use of a rigid structure, such as concrete, in addition to an FML may be problematic. While the FML is intended to prevent the migration of leachable pollutants from the hazardous waste, it may be defeated by the natural deterioration that can be expected in an unreinforced concrete slab. Differential settlement may cause cracking of the concrete and lead to movement that may exceed the shear strength of the FML liner thereby causing a tear of the liner and subsequent leakage of leachate. Differential settlement may be caused by the action of mechanized equipment delivering or handling the solid waste placed into the landfill or by the varying weight and density of various materials placed in different sections of the landfill. It is recommended that a flexible liner system composed of impermeable layers and drainage layers be used. Design considerations are discussed in section 4.2.1 and Appendix K of this report.

2. No leachate collection, treatment, and disposal system is evident from the preliminary drawings. While leachate generation is expected to be minimal as a result of climatic conditions in the 10th of Ramadan City area, leachate will be generated as a result of the inherent moisture content of various industrial wastes. For example, dewatered wastewater treatment plant sludge may still contain up to 70 percent moisture when transported to the disposal site. A leachate collection and disposal system is necessary to prevent leachate from contacting the liner and eliminate potential migration downwards. The use of evaporation ponds as a leachate treatment system should be evaluated for the 10th of Ramadan hazardous waste landfill. Design considerations are discussed in section 4.2.1 and Appendix K of this report.

3. The need for groundwater monitoring and a gas collection system should be evaluated in the design of the proposed hazardous waste landfill for the 10th of Ramadan Industrial City.

4. A cover system over the hazardous waste landfill is necessary for protection of public health and the environment as discussed in section 4.2.9. Generally, the cover system should consist of a low permeability layer over the waste (60 cm thick with permeability less than or equal to 10^{-7} cm/sec), overlain by a drainage layer (30 cm thick with permeability of at least 10^{-3} cm/sec), followed by a layer of topsoil (60 cm thick) to support vegetation. Adjustments to the design of the final cover system can be made to suit site conditions such as in arid regions in Egypt.

5.3 Economic Evaluation

The hazardous waste landfill for the 10th of Ramadan is proposed as a fully private operation. A new company has been formed to invest in environmental development in the city, and this company has expressed an interest in constructing and operating the landfill. The principal investors in the new company, however, have stressed that the company is a business and needs to make a return on its investments. Therefore, cost recovery is a critical component of success for the proposed landfill.

For the proposed landfill to be a success, the investors must be able to recover capital and operating costs and make a reasonable return on their investment. It is beyond the scope of this report to assess the financial feasibility of the proposed landfill. Much of the information needed for a financial feasibility analysis is not currently available. In order to accurately do a financial feasibility analysis, information is needed on the design of the landfill as well as the quantity of waste that will be disposed of in the landfill.

To provide an indication of what the landfill might cost and what a tipping fee may have to be to recover the costs, the evaluation team had to make some assumptions about the design of the facility. The assumptions are as follows:

1. The landfill would be designed and constructed to receive wastes for five years at a rate of 1,000 tonnes per month.

2. A cubic meter of hazardous waste weighs 1.2 tonnes (the ratio used in the Greater Cairo Study[5]).

3. Cover material will occupy ten percent of the volume of the landfill.

4. The depth of the landfill will be 5.5 meters and its final cover will be at ground surface level, so it will occupy 10,000 square meters.

5. For the purpose of this cost estimate alone, the design of the landfill would be similar to that proposed in the Greater Cairo Study[6].

To estimate the costs of the landfill, the team used cost estimates from two sources: 1) unit cost estimates from the greater Cairo Study[7], and 2) cost estimates from the 1994 effort to develop a private non-hazardous solid waste landfill in the 10th of Ramadan Industrial City. Table 6 presents the estimated capital and operating costs for the landfill. Note that the cost of land is not included in these estimates, as the Minister of Housing, Utilities and New Communities granted the development company the right to use the land for a hazardous solid waste landfill at no cost.

Table 6
Rough Cost Estimates for 10th of Ramadan Hazardous Waste Landfill

Cost Category	Cost (L.E.)
Capital Costs	
Landfill*	3,500,000
Buildings and Associated Equipment** †	152,000
Vehicles and Heavy Equipment**	620,000
Design (10% of capital costs)	427,200
Subtotal	4,699,200
Contingency Fee (15% of Subtotal)	704,880
Total Capital Costs	**5,404,080**
Annual Operating Costs	
Personnel**	200,000
Maintenance and Administration (15% of Personnel Cost)	30,000
Total Annual Operating Costs	**230,000**

Notes:
* Based on a cost of \$103 per m^2, from Industrial Hazardous Waste Management in Greater Cairo Urban Region, Table 4.1, p. 52.
** Estimated costs in 1994 by the operator of the private non-hazardous waste landfill in the 10th of Ramadan Industrial City.
† This estimate, being based on buildings and associated equipment for a non-hazardous waste landfill, does not include specialized equipment that may be required at a hazardous landfill.

---

[5] El Haggar, Salah. 1999. Industrial Hazardous Waste Management in Greater Cairo Urban Region. EEAA, TCOE, p. 51.
[6] Ibid. Chapter 4.8, pp. 50-52. This design does not include leak detection.
[7] Ibid. Table 4.1, p. 52

To estimate the revenue necessary to recover the capital and operating costs, the evaluation team had to make additional assumptions regarding the cost recovery period and the rate of return on investment. Assuming that the investors will want to recover their costs in a five-year period and make a 10 percent rate of return, the team estimated that the landfill would have to generate 135,904 L.E. per month. If we assume that 1,000 tonnes per month will be disposed of in the landfill, then the tipping fee will have to be 136 L.E. per tonne of hazardous solid wastes.

The estimate of 136 L.E. per tonne can only be viewed as an order of magnitude estimate of the fee required to recover costs at the hazardous solid waste landfill. Once more accurate data is collected on the types and volumes of hazardous wastes, and decisions are made about the design standards for the landfill, a full feasibility analysis should be conducted.

Although the estimate is very preliminary, it does indicate that the fee will represent a significant increase in the current cost of hazardous solid waste disposal. For instance, the general manager at one company, which is currently identified as a hazardous solid waste generator by the EFNIC database, reported to the team that he pays 25 L.E./tonne to have the wastes hauled away from the plant. To the best of his knowledge, this fee is for transport alone, as the dumpsite does not charge a tipping fee. In his case, disposal of the hazardous wastes at the landfill would cost an additional 136 L.E. per tonne, raising his total cost to 161 L.E. per tonne, or more than six times his current cost.

5.4 Interim Hazardous Waste Storage Facility

Given the current status of information on hazardous waste in the EFNIC database and the need for much more work on the design and operation of a hazardous waste landfill, the team recommends that the MSEA consider constructing a secured interim hazardous waste storage facility adjacent to the site of the proposed hazardous waste landfill. This facility could be constructed in a relatively short time, and would have several advantages such as:

1. Segregating hazardous from non-hazardous solid waste,
2. Bringing hazardous waste to a centralized secured facility instead of the public dumpsite,
3. Creating opportunities for profitable waste exchange,
4. Minimizing the health risk to workers at the public dumpsite who currently segregate recyclable material manually from the mixed hazardous and non-hazardous solid waste,
5. Initiating the hazardous waste management activity in the 10th of Ramadan Industrial City and creating an awareness among the industries in the city,
6. Facilitating the process of meeting the goals of the fast-track activity in the EFNIC program, and

7. Providing time to collect more accurate data on waste generation, arrange for the design, construction, and operation of the landfill per appropriate specifications, and establish institutional and financial mechanisms.

Waste from the interim facility can be disposed in the landfill as soon as it is operational. Once the landfill is in operation, the interim storage facility would be used as a staging area for the landfill and could eventually include waste treatment facilities.

It is envisioned that there would be generally two groups of hazardous waste coming into this facility. One group of waste would be containerized such as in drums. The other group would be in bulk form such as dewatered sludge filter cake, and other bulky wastes. Some of the key elements to consider in the design of the interim storage facility are as follows.

Containerized storage - Several factors should be considered in designing the container storage area. These factors include but are not limited to:

a. Condition and type of containers
b. Chemical compatibility of waste within the containers,
c. Management and handling of containers to avoid rupture,
d. Segregation of incompatible wastes,
e. Containers are to be properly labeled indicating type of waste.

Container storage areas should be on a sufficiently impervious base (preferably paved), free of cracks and gaps, to contain leaks, spills, and accumulated precipitation. The base should be sloped to drain any liquids spilled using sumps and pumps. The container storage area for hazardous liquid waste storage should have a secondary containment system such as a berm or walled area with sufficient capacity to contain 10 percent of the volume of the total containers or the volume of the largest container, whichever is greater. Surface water run-on into the containment area must be prevented. There should be adequate aisle space between rows of containers in order to allow easy access for loading, unloading and removing the containers for disposal and for emergency response vehicles. Stacking height of containers should be limited based on supplier recommendations for different containers to avoid damage due to failure from excessive loading. Containers holding ignitable or reactive waste should be located at least 15 meters from the facility's property line. A minimum weekly inspection should be conducted by trained staff looking for leaking containers, and for deterioration of containers caused by corrosion or other factors. The team recommends that the container storage area be covered with a simple shed-like roofing system with the sides being open. This would prevent potential hazards due to excessive heat from exposure to sunlight, and wind erosion effects.

Bulk storage area - The bulk storage area should be designed for bulky wastes that are not containerized such as dewatered sludge filter-cake. The storage area may be divided via partitions (berms, etc,) for storing different types of wastes with provision for easy access for loading and unloading the material using loaders. The storage area should be covered to avoid excessive heat exposure and wind erosion and dust dispersion. It is recommended that the base of the bulk storage area be made of a sufficiently impermeable material that is locally available.

6 Evaluation of Institutional Mechanisms

6.1 Components of a Sustainable Institutional Structure

A sustainable institutional structure is necessary for the success of any hazardous or non-hazardous solid waste management program. The institutional structure must provide the necessary incentives to encourage compliance with adopted standards for solid waste segregation, storage, collection, transport, reuse, treatment, disposal, and destruction. Enforcement of standards is a necessary requirement for sustainability of a solid waste management program. Economic incentives can also be used to encourage compliance with standards.

A recent international study on hazardous waste program development[8] concluded that building an effective regulatory program is a key component of implementing a hazardous waste management program. This conclusion is also applicable to non-hazardous waste. Effective regulation is critical because it creates demand for proper waste disposal.

Waste disposal, in and of itself, is not a marketable product. Although some of the materials in a waste stream may be profitably recovered, the materials that cannot be profitably recovered must be disposed of, and disposal incurs costs without creating a financial return to the waste generator. Proper disposal is more costly than improper disposal. So in the absence of effective regulations requiring proper disposal, a company striving to maximize its profit will choose the less costly disposal method -- improper disposal.

In many countries, hazardous and non-hazardous solid waste disposal is a private industry. Waste generators pay disposal companies to transport and dispose of their wastes. In these instances, waste management is a profitable business. But it is only a profitable business because effective regulation has created a market for proper waste disposal.

Economic incentives are another mechanism for encouraging compliance with waste management standards. Some economic incentives to reduce the generation and disposal of hazardous and non-hazardous solid wastes are always present in a free market system. These are realized when a generator of waste reduces its costs by recycling waste into its production stream or finding a market for selling the waste. Many of the industries in the 10th of Ramadan already recycle or sell at least some of the waste they generate.[9] These incentives can be further enhanced through pollution prevention audits, which help companies identify additional opportunities for reuse or sale of wastes. However, such internal economic incentives seldom completely reduce waste generation, and do not create incentives for proper disposal of residual wastes.

[8] Probst, Katherine N. and Thomas C. Beierle. 1999. The evolution of hazardous waste programs: Lessons learned from eight countries. RFF Report, Center for Risk Management, Resources for the Future. Washington, DC.
[9] See, for instance, the frequent presence of "recycled" or "sold" as means of disposal for hazardous and non-hazardous by the generators listed in Appendix J.

Economic incentives to reduce waste generation and encourage proper disposal can be created via discharge fees. If the revenues generated from the fees are used for operation of a waste management program, they can also create incentives for companies to deliver wastes to a management facility, by reducing or even eliminating the marginal cost of waste disposal. One special form of a discharge fee is a deposit/refund fee, which creates even greater incentive for delivery of waste to a facility by providing a partial fee refund for wastes that are delivered.

A discharge fee generates revenue that can be used to operate a waste management facility. This is particularly important in situations where compliance with standards is not enforced. In such a case, it is unlikely that generators will deliver waste to a facility at which they must pay a tipping fee, thus making it unattractive to private facility operators. However, if a discharge fee generates enough revenue to cover the costs of operation, the government can use the fee to contract for facility operation. If the facility is fully funded by such a fee, then the marginal cost of disposal can be reduced to zero, thereby eliminating the economic disincentive to deliver waste to the facility.

Implementation of a discharge fee does not eliminate the need for program enforcement. At a minimum, it changes the point of enforcement from compliance with management regulations to payment of the fee. However, optimally a program should enforce both regulations and fee collection to create multiple incentives for proper waste management.

6.2 Legal Requirements for Hazardous and Non-Hazardous Solid Waste in Egypt

Egypt has laws and regulations governing hazardous and non-hazardous solid waste management. Law No. 38 of 1967 and its implementing regulations (Minister of Housing Decree No. 134 of 1968) govern the collection, transport, and disposal of non-hazardous solid waste in Egypt. The law and its regulations require that wastes be disposed of in sanitary landfills[10] surrounded by a 1.8-meter fence. Law No. 4 of 1994 and its implementing regulations (Prime Minister's Decree No. 338 of 1995) banned open burning of solid waste[11].

Hazardous wastes are also regulated by Law No. 4 of 1994 and its implementing regulations. The law requires permits from "the competent administrative authority" for handling, treating, and disposing of hazardous wastes and requires that the wastes be handled, treated, and disposed of in accordance with procedures, norms, and conditions to be established by the implementing regulations. The implementing regulations identified six competent administrative authorities: Ministry of Industry and Mineral Resources, Ministry of Agriculture, Ministry of Health, Ministry of Petroleum, Authority for Nuclear Energy in the Ministry of Electricity, and Ministry of Interior. Each authority, in coordination with EEAA, is responsible for promulgating lists of hazardous substances and wastes and for developing and

[10] Article 17 of the implementing regulations require that the waste be disposed of in piles or trenches that are compacted, covered with no less than 15 centimeters of sand, and sprayed with water.
[11] Article 38 of the implementing regulations allowed for a three-year period during which open burning was allowed under special conditions, but the three year period ended in 1998.

implementing permit procedures for its area of responsibility. The regulations also included general rules and procedures for generation, collection, storage, transport, treatment, and disposal of hazardous waste.

Implementation of non-hazardous solid waste laws and regulations is the responsibility of local authorities via their administrative procedures. Implementation of hazardous waste laws and regulations is the responsibility of each competent administrative authority via its permitting procedures, although in some cases implementation must be coordinated with EEAA and other governmental authorities.

6.3 Implementation of Laws and Regulations in 10th of Ramadan Industrial City

The laws and regulations for the disposal of non-hazardous solid waste are not currently being fully implemented in the 10th of Ramadan Industrial City. The dumpsite is not fenced, does not meet the criteria for compaction and cover, and is in violation of the ban on open burning. The presence of multiple piles of solid waste along the roadside between the city and the dumpsite is another indication of the lack of enforcement of solid waste laws and regulations.

The impact of lack of enforcement on effective solid waste management can be seen in the case of a failed private non-hazardous solid waste sanitary landfill opened in the 10th of Ramadan in 1994. In that year, a private entrepreneur constructed and operated a landfill that met the requirements of the law and regulations. He did so assuming that the passage of Law No. 4 would create a market for proper solid waste disposal. The entrepreneur designed his facility and completed a financial feasibility analysis. The analysis identified that he should charge a tipping fee of 9.00 L.E. per tonne of waste received to recover his costs and make a reasonable profit. But his landfill was a financial failure. The laws and regulations governing solid waste disposal were not enforced, so generators continued to dispose of their waste for free in the desert, rather than paying a fee to dispose of it in the sanitary landfill. Even when the entrepreneur lowered his fee to 5.00 L.E. per tonne (a rate at which he could not recover his investment) he could not attract enough waste to keep the facility open. During the time that the landfill was opened, it received less than ten percent of the total solid waste generated in the city.

The City Development Agency plans to implement a program to ban illegal dumping of solid waste. In December of 1999 it sent letters to the industries in the city informing them that beginning in January of 2000 the city will begin to enforce the laws and regulations against illegal dumping. If the city follows through with this program, it will create incentives for delivery of wastes to the city dumpsite.

The enforcement structure for hazardous waste does not currently exist. The Ministry of Industry and Mineral Resources is responsible for promulgating the list of hazardous wastes and the permit requirements for handling hazardous wastes. The Ministry has produced a draft list of wastes (see Appendix D), but the list has not been officially adopted, so there is no legal definition of industrial hazardous wastes. The Ministry has not promulgated permit requirements for handling industrial hazardous wastes.

The Egyptian Environmental Policy Program plans to work with EEAA, the City Development Authority, the 10th of Ramadan Board of Trustees, and the 10th of Ramadan Investors Association to implement the Integrated Environmental Management System (IEMS). The IEMS is a coordinated system of economic incentives, regulatory enforcement, and voluntary pollution prevention to secure compliance with the industrial pollution control requirements of Law 4. The system includes the creation of sustainable institutional and financial mechanisms for compliance. Implementation of the EIMS should create incentives for proper hazardous waste management.

The IEMS includes an environmental fund. The fund is to be used for several purposes, including: support of the municipal enforcement system, loans or grants to industry for pollution prevention and control, investment in central waste services, and maintenance of the IEMS database. Under the preliminary design for the IEMS, income to the fund will come primarily form discharge fees paid by industry. The proposed discharge fee system includes a fee for the generation of hazardous wastes, calculated as follows:

Hazardous Waste Fee for Firm i = (R_w x Q_i x M_i)

Where: R_w = Rate per tonne of hazardous waste generated

Q_i = Quantity (tonnes/month) of hazardous waste generated from Firm i

M_i = 0.5 or 1.0 If Firm i is in compliance with monitoring and reporting requirements of the IEMS M = 0.5. If not, M = 1.0.

The preliminary estimate of R was 5.0 L.E. per tonne, and its primary objective was to finance a waste exchange program.[12] EEPP will be reevaluating the fee design in early 2000, prior to its implementation.

[12] Draft Environmental Management Guidelines for 10th of Ramadan City, Volume I: Government Guidelines, USAID/Egypt, 1997, Chapter 7.4.

7 Implementation Plan

Work to date demonstrates the recognition by the Ministry of State for the Environment and the City Development Agency that effective hazardous and non-hazardous solid waste management must be accomplished if the 10^{th} of Ramadan Industrial City. To that end, the evaluation team believes that the following steps should be taken to implement an effective integrated solid waste management system that addresses all components of the industrial solid waste stream in the 10^{th} of Ramadan Industrial City. These implementation tasks provide the road map for effective integrated solid waste management in the city.

Because new industrial cities have many common solid waste management problems, many of the recommendations and approaches in this report can be applied to the other industrial cities in Egypt. They are also not specific to whether the private or public sector develops the individual components of the solid waste management system. There should be no significant differences in criteria for effective designs and operating procedures if public or private developers implement them.

7.1 Solid Waste Generation Database

With the existing database as a starting point, the following procedures that should be undertaken to realize the full utility of the database.

1. Modify the database structure to include:

    a. A more comprehensive grouping of industries into logical categories as in proposed Table 2.

    b. Fields for reporting more than one type and quantity of hazardous and non-hazardous waste.

    c. A definition of special wastes and a field for reporting information on them.

    d. Uniform units of measurement for waste quantities.

    e. Fields for providing more detail about current waste recycling, sale and disposal practices.

2. Develop and adopt an interim classification system for identifying hazardous industrial waste by which an industry can identify its hazardous waste through either existing knowledge or laboratory testing.

3. Communicate the interim classification standard to all applicable industries in accordance with the database register for comment and review.

4. Use the waste classifications from the classification system as the "type of waste" entries in the database.

5. Provide support to the adoption of a national hazardous waste classification system.

6. Develop generic process flow diagrams and process/waste production summaries for each category of industries using the information sources presented in Appendices G and H. These process flow diagrams and summaries will form the basis for staff training and for determining the type of information required of individual industries.

7. Assign EFNIC field interview staff responsibility for an industrial category or group of categories so as to focus on building specific experience and knowledge for their areas of focus.

8. Train EFNIC field interview and enforcement staff on the following issues as soon as possible for further refinement of the solid waste generation database:

    a. Process configurations and general waste generation characteristics within the industries in the categories assigned to them.

    b. The definition of hazardous waste as adopted through the development of the interim classification standard.

    c. Testing procedures and the interpretation of test data for the evaluation of industrial waste streams and categorization of waste materials as hazardous or non-hazardous.

7.2 Development of the Hazardous Solid Waste Disposal Area

The following are procedures that should be followed to design and implement an appropriate hazardous waste disposal area in the 10^{th} of Ramadan Industrial City.

1. Determine existing and projected hazardous and non-hazardous solid waste quantities and characteristics through further refinement and development of the EFNIC hazardous and non-hazardous solid waste database.

2. Develop design and operational standards for hazardous management based on information presented in and transmitted with this report and an assessment of environmental risks at the proposed site.

3. Develop design and operational standards for an interim hazardous waste storage facility including fencing, controlled access point, and any surfacing required for effective management of waste delivery vehicles.

4. Develop terms of reference for the design and construction of the interim hazardous waste storage facility.

5. Complete the design of an interim hazardous waste facility.

6. Develop an operations plan for the interim facility.

7. Commence construction and operation of the interim hazardous waste storage facility.

8. Develop design and operational standards for the permanent hazardous waste TSDF based on information presented in and transmitted with this report. The TSDF should include a hazardous waste landfill and associated facilities as Phase 1.

9. Develop terms of reference for design and construction of the hazardous waste landfill and associated facilities.

10. Complete the design of the landfill.

11. Develop an operations plan for the landfill

12. Commence construction and operation of the landfill and transfer operations from the interim facility.

13. Develop terms of reference for design and construction of subsequent phases of the TSDF.

14. Complete the preliminary and final design of the TSDF.

15. Develop an operations plan for the TSDF.

16. Commence construction of the TSDF.

17. Commence operation of the permanent TSDF.

7.3 Development of Non-Hazardous Solid Waste Management System

The 10^{th} of Ramadan Industrial City has already privatized municipal solid waste collection. The following procedures should be followed to address the missing components of an effective non-hazardous solid waste management program.

1. Determine existing and projected non-hazardous solid waste quantities and characteristics through further refinement and development of the non-hazardous components of the EFNIC solid waste database and estimates of municipal solid waste.

2. Determine and evaluate the extent of non-hazardous solid waste recycling and sale at the industries within the 10^{th} of Ramadan.

3. Determine and evaluate the extent of markets for recyclable materials within the 10^{th} of Ramadan region.

4. Develop and maintain a waste exchange database for industries within the 10^{th} of Ramadan.

5. Evaluate the feasibility of developing other means for solid waste stream reduction including recycling, composting and any other process that can reduce the amount of non-hazardous solid waste requiring disposal.

6. Improve standards of operations at the current disposal site through development of an interim operations plan aimed at mitigating existing environmental and health effects.

7. Develop interim controlled access for non-hazardous waste disposal in conjunction with development of the interim hazardous waste storage facility.

8. Develop terms of reference for the design and construction of a permanent non-hazardous waste disposal facility based on risk-based design procedures for key components.

9. Complete the design of the non-hazardous waste facility.

10. Develop a detailed plan of operations based on processing and disposal design.

11. Commence construction and operation of the non-hazardous solid waste landfill.

7.4 Development of a Supporting Institutional Program

Effective implementation of an integrated solid waste management program requires an effective institutional structure. The following are procedures that should be followed to develop an effective institutional program in the 10^{th} of Ramadan Industrial City to support integrated solid waste management, including enforcement and funding.

1. Implement the City's ban on uncontrolled dumping.

2. Develop a national classification system for hazardous waste.

3. Develop a national hazardous waste permit system.

4. Develop an action plan for the institutional structure to implement the IEMS, including identification of local enforcement mechanisms.

5. Develop an action plan for the funding mechanism to implement the IEMS.

6. Prepare a financial feasibility studies for proposed hazardous and non-hazardous waste management.

7. Implement the IEMS.

7.5 Implementation Timeline

The timeline shown in Figure 3 attempts to integrate a number of parallel activities that are aimed at achieving integrated solid waste management in the 10^{th} of Ramadan Industrial City. The evaluation team views these activities as crucial to successful implementation of effective hazardous and non-hazardous solid waste management. Based on the implementation tasks described above, a number of key accomplishments can be realized. While the initial definition of these accomplishments is focused on the 10^{th} of Ramadan, they will be important in achieving similar objectives in the other industrial cities. Key measurable accomplishments shown in the timeline are:

1. Completion of the 10^{th} of Ramadan industrial waste database for use in planning and to serve as a model for other industrial cities.

2. Adoption of an interim hazardous waste classification system for use in the 10^{th} of Ramadan Industrial City.

3. Development of an interim hazardous waste storage facility allowing near-term segregation of the hazardous and significantly reducing the risk of health effects to informal recyclers at the city dumpsite.

4. Development of detailed terms of reference for a permanent hazardous waste management facility.

5. Completion of the design and construction of an effective hazardous waste management facility to serve the 10^{th} of Ramadan industries for the long term.

6. Improve standards of operations at the current city dumpsite through development of an interim operations plan aimed at mitigating existing environmental and health effects.

7. Commencement of effective planning for disposal of non-hazardous solid waste generated by residents and industries in the 10^{th} of Ramadan.

Insert Figure 3

Task Order No. 832
Contract No. PCE-I-96-00002-00

HAZARDOUS AND NON-HAZARDOUS SOLID WASTE MANAGEMENT IN THE 10TH OF RAMADAN INDUSTRIAL CITY

Volume 2
Appendices

By
Avijit Dasgupta PhD P.E.
Mostafa Eissa
Lane Krahl
Leo R. Larochelle P.E.

June, 2000

For
Egyptian Environmental Policy Program
Program Support Unit

Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)

Contents

Preface

Through competitive bidding, the U.S. Agency for International Development (USAID) awarded a multi-year contract to a team managed by International Resources Group, Ltd. (IRG) to support the development and implementation of environmentally sound strategic planning, and strengthening of environmental policies and institutions, in countries where USAID is active. Under this contract, termed the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ), IRG is assisting USAID/Egypt with implementing a large part of the Egyptian Environmental Policy Program (EEPP).

This program was agreed-to following negotiations between the Government of the United States, acting through USAID, and the Arab Republic of Egypt, acting through the Egyptian Environmental Affairs Agency (EEAA) of the Ministry of State for Environmental Affairs, the Ministry of Petroleum's Organization for Energy Planning, and the Ministry of Tourism's Tourism Development Authority. These negotiations culminated with the signing of a Memorandum of Understanding in 1999, whereby the Government of Egypt would seek to implement a set of environmental policy measures, using technical support and other assistance provided by USAID. The Egyptian Environmental Policy Program is a multi-year activity to support policy, institutional, and regulatory reforms in the environmental sector, focusing on economic and institutional constraints, cleaner and more efficient energy use, reduced air pollution, improved solid waste management, and natural resources managed for environmental sustainability.

USAID has engaged the EPIQ contractor to provide Program Support Unit (PSU) services to EEPP. The PSU has key responsibilities of providing overall coordination of EEPP technical assistance, limited cross-cutting expertise and technical assistance to the three Egyptian agencies, and most of the technical assistance that EEAA may seek when achieving its policy measures.

The EPIQ team includes the following organizations:

- Prime Contractor: International Resources Group
- Partner Organizations:
  - Winrock International
  - Harvard Institute for International Development
- Core Group:
  - Management Systems International, Inc.
  - PADCO
  - Development Alternatives, Inc.
- Collaborating Organizations:
  - The Tellus Institute
  - KBN Engineering & Applied Sciences, Inc.
  - Keller-Bliesner Engineering
  - Conservation International
  - Resource Management International, Inc.
  - World Resources Institute's Center For International Development Management
  - The Urban Institute
  - The CNA Corporation.

For additional information regarding EPIQ and the EEPP-PSU, contact the following:

United States of America:

EPIQ Prime Contractor
International Resources Group, Ltd
1211 Connecticut Ave, NW
Suite #700
Washington, DC 20036
Telephone: (1-202) 289-0100
Facsimile: (1-202) 289-7601

Egypt:

EEPP-PSU
International Resources Group, Ltd
21 Misr Helwan Agricultural Road
Office 62, 6th Floor
Maadi, Cairo
Telephone: (20-2) 380-5150
Facsimile: (20-2) 380-5180

Contact:	Douglas Clark	Contact:	Harold van Kempen

Appendix A

Initial Support for Hazardous and Non-Hazardous Waste Management in the 10th of Ramadan Industrial City

Scope of Work

I. Background

The governments of the United States and the Arab Republic of Egypt have signed a memorandum of understanding to implement the Egyptian Environmental Policy Program (EEPP), a four-year program to support policy, regulatory, and institutional reforms that promote environmental quality and protect natural resources. The program is focused on accomplishing policy objectives. Three of the current policy objectives address control of industrial pollution. The activities proposed in this scope of work fall under policy objective 9 -- MOEA/EEAA, in cooperation with industrial stakeholders and relevant GOE entities, will develop pollution reduction strategies which will generate higher rates of compliance. During the first 18 months of EEPP, activities under this policy objective are focused on assisting EEAA, in association with the Investors' Group and relevant stakeholders, to design and initiate implementation of the integrated Environmental Management System (EMS) for the 10th of Ramadan Industrial City.

The activities proposed in this scope of work will build upon experience gained under the fast track program for environmental rehabilitation of the new industrial cities (NICs) in Egypt, presently being implemented under the auspices of the Ministry of State for Environmental Affairs. A component of this program is the Environmental Friendly New Industrial Cities program (EFNIC). The EFNIC is a public-private partnership between business, government, and the community through which an NIC is expected to meet the broad goals of providing: healthy living in residential districts, suitable work environments in production facilities, compliance with pertinent regulations for industrial emissions, and compliance with ambient environmental quality standards. Proper management of hazardous wastes is one of the criteria for EFNICs as well as an essential component of any industrial-based EMS.

The 10th of Ramadan Industrial City is one of the five cities included in the first phase of the EFNIC. The first phase is scheduled for completion in December, 2000, by which time the Egyptian Government anticipates that the five cities will be able to be declared as Environmentally Friendly.

Currently, hazardous wastes generated by industrial facilities in the city are discharged to the wastewater system or co-disposed of with non-hazardous wastes in dumping sites. Neither of these disposal methods are in compliance with Environmental Law 4/94. Solid wastes of a potentially hazardous nature commonly found in the 10th of Ramadan include:

- Off-specification products;
- Chemicals used in production whose date for appropriate use has expired;
- Materials spilled, lost, or having undergone other mishap including any materials, equipment etc. contaminated as a result of the mishap;

- Materials contaminated or soiled as a result of planned actions (e.g. residues from cleaning operations, packing materials, containers);
- Unusable parts, (e.g. exhausted catalyst);
- Substances which no longer perform satisfactorily (e.g. contaminated acids, contaminated solvents);
- Residues of industrial processes, (e.g., still bottoms);
- Residues from pollution abatement processes, (e.g., scrubber sludges, baghouse dusts, spent filters);
- Machining/finishing residues, (e.g., lathe turnings, mill scales); and
- Residues from raw materials processing.

The hazardous constituents in the form of liquid or sludge may include:

- Residue from substances employed as solvents;
- Halogenated organic substances not employed as solvents;
- Tempering salts containing cyanide;
- Mineral oils and oily substances,(e.g., cutting sludges);
- Oil/water, hydrocarbon/water mixtures, emulsions;
- Substances containing PCBs and/or PCTs;
- Inks, dyes, pigments, paints, lacquers, varnish;
- Resins, latex, plasticizer, glues/adhesives;
- Pytotechnics and other explosive materials;
- Non-halogenated organic substances not employed as solvents;
- Inorganic substances without metals;
- Ashes and/or cinders;
- Non-cyanidic tempering salts;
- Metallic dust, powder;
- Spent catalyst materials;
- Liquids or sludges containing metals;
- Residue from cleaning of tanks and/or equipment; and
- Contaminated containers (e.g., packaging, gas cylinders, etc.).

Comprehensive information on the volumes and specific types of waste generated in the 10th of Ramadan Industrial City is not available. Ministry of State for Environmental Affairs is currently collecting data on waste generation in the 10th of Ramadan Industrial City of the 700 industrial facilities in the city. Information has been collected for less than one-quarter of the facilities. This information needs to be reviewed to determine its suitability for comprehensive hazardous and non-hazardous waste management planning.

To address the <u>immediate</u> hazardous waste issue in the 10th of Ramadan Industrial City, the Investors' Association has proposed that a hazardous waste landfill be constructed on a site designated by the government. The landfill will serve all industrial facilities in the city. Investors in the city have expressed an interest in participating in the construction and operation of a centralized facility. An Egyptian engineering firm has prepared a design for this landfill. The design, which is in Arabic, needs to be reviewed by a competent technical specialist to determine if it can provide safe and environmentally secure disposal of hazardous wastes. The proposed institutional structure for managing the landfill also needs to be reviewed to determine if it is capable of ensuring that only the wastes for which the landfill is designed are disposed of at the landfill and that they are transported and disposed of in a safe and environmentally secure manner.

The proposed hazardous waste landfill may help the 10th of Ramadan Industrial City meet the immediate need for adequate hazardous waste disposal, but many regard it as only a temporary solution to the greater hazardous waste management issues facing the city. To properly address long-term management of hazardous waste, a more comprehensive and systematic approach to hazardous waste management needs to be developed. A comprehensive system would address waste classification and separation, on-site storage, transportation, recycling and reclamation, destruction, and disposal. Development of a hazardous waste management system for the 10th of Ramadan Industrial City must take place within the broader context of a national hazardous waste management program for Egypt. It must address regulatory, institutional, economic, and technical needs for hazardous waste management.

Before a comprehensive hazardous waste management system can be developed for the 10th of Ramadan Industrial City, data must be compiled for current and projected volumes and specific types of hazardous waste generated by industrial facilities. Using this information, technical options for separation, storage, collection, transportation, treatment, destruction, and disposal of hazardous waste must be identified and assessed, including options for waste reduction, recycling, reclamation, and regeneration and the sizing of facilities.

Development of a comprehensive hazardous waste management system must also assess the current regulatory and institutional framework for hazardous waste management in Egypt, as well as the institutional capacity of the responsible environmental authorities in the 10th of Ramadan Industrial City to ensure compliance with those regulations. It must examine the economics of hazardous waste management and identify opportunities for private sector involvement in the management system, as well as assess the potential use of economic incentives to encourage and, when necessary, ensure compliance.

Currently, hazardous and non-hazardous solid wastes are co-disposed of in the 10th of Ramadan Industrial City. Neither is disposed of in compliance with Environmental Law 4/94. Addressing the hazardous waste problem via development of a comprehensive hazardous waste management system will only partially address the broader waste management issue. To address the broader issue requires development of an overall approach to waste management, where wastes are categorized according to their characteristics, and then managed accordingly. With regard to solid, non-hazardous wastes, opportunities exist to recover various resources, such as paper, plastics, metals, glass, and energy as well as to produce marketable products such as compost. Similar opportunities exist for hazardous waste in the form of turning wastes into viable products. Treating wastes as products can create economic incentives for better waste management and generate revenues for waste treatment and disposal.

Development of a comprehensive private sector owned and operated non-hazardous solid waste management system for the 10th of Ramadan Industrial City requires the collection of current and projected data on the volumes and types of waste generated, as well as the sources of wastes (domestic, commercial, and industrial), and the geographic distribution of the sources. A comprehensive management system must encompass all phases of solid waste management, including collection, transfer stations (if necessary), transportation, treatment (including recycling and composting), and disposal. The system must be developed taking into consideration the regulatory and institutional framework for solid waste management and the institutional capacity to operate the system or monitor private operation of the system. Financial analysis must also be conducted to identify opportunities for public-private partnerships for solid waste management based on fees to sustain these services.

II. Objectives

The objectives of the work proposed in this document are to:

- identify the technical data needs for comprehensive hazardous and non-hazardous waste management planning in the 10th of Ramadan Industrial City,

- provide comments to the government of Egypt on the proposed hazardous waste landfill for the 10th of Ramadan Industrial City, and

- create a road map for the development of integrated management systems for hazardous and non-hazardous wastes in the 10th of Ramadan Industrial City and identify opportunities for private sector owned and operated systems.

Clearly, more is needed to help the 10th of Ramadan Industrial City and the government of Egypt to develop comprehensive hazardous and non-hazardous waste management systems. The results from the work described in this document will provide input to the development those systems; however, the development of the systems will have to be addressed in the work planning process for EEPP.

III. Tasks

A. <u>Identify the technical data needs for comprehensive hazardous and non-hazardous waste management in the 10th of Ramadan Industrial City</u>

- Visit a representative sample of the types of industrial facilities and residential and commercial establishments in the 10th of Ramadan Industrial City from which data will have to be collected.
- Identify an appropriate system for the categorization of solid hazardous and non-hazardous wastes in the 10th of Ramadan Industrial System. The system should be based on an internationally recognized system such as those used by USEPA or the World Bank, or contained in the Basel Convention and compatible with the categorization systems used in the Greater Cairo and Alexandria hazardous waste programs.
- Review available data on the specific types and volumes of hazardous and non-hazardous waste currently generated by industrial facilities, commercial establishments and domestic residences in the 10th of Ramadan Industrial City.

- Review hazardous waste technical studies undertaken by (a) the fast track program at 10th of Ramadan, (b) DANIDA-TCOE reports on Greater Cairo, and (c) FINIDA-TCOE reports on Alexandria.
- Review non-hazardous waste studies including (a) SEAM-EEAA reports on solid waste management, and (b) USAID-Governorate of Alexandria solid waste management implementation plan.
- Assess the quality of existing data on hazardous and non-hazardous waste generation in the city and identify any additional data needs that will be required for waste management facility design, and financial analysis.
- Develop, with the MOEA and EEAA, a questionnaire or other mechanisms to collect additional data (if necessary) and a system for quality control.
- Test the questionnaire or other mechanism on a representative sample of facilities.
- Train the individuals who will implement data collection in the use of the questionnaire or other mechanism. This training should be conducted in a "train the trainers" fashion so that the recipients of the training can train others in how to use the data collection system.

B. <u>Provide comments to the government of Egypt on the proposed hazardous waste landfill for the 10th of Ramadan Industrial City</u>

- Translate the proposed design into English.
- Visit the proposed site for the landfill, some of the principal waste generating facilities.
- Provide comments on the technical viability of proposed design.
- Identify if the design adequately addresses issues of potential commercial resource recovery and financial viability.
- Interview representatives of the institutions that will operate and monitor the landfill.
- Review the proposed management structure for the design and assess the institutional capabilities and needs for its implementation.

C. <u>Create a road map for the development of integrated management systems for hazardous and non-hazardous wastes in the 10th of Ramadan Industrial City</u>

- Visit other new industrial cities and meet with representatives from the responsible private and public agencies to learn how they are addressing or planning to address hazardous and non-hazardous waste management.
- Survey the hazardous and non-hazardous waste management situation in 10th of Ramadan Industrial City.
- Prepare a road map for the development of integrated management systems for hazardous and non-hazardous wastes in the 10th of Ramadan Industrial City.
  ? The road map must be practical in the Egyptian context and helpful not only to the 10th of Ramadan, but to other newly industrialized cities facing similar problems.
  ? It must identify opportunities for private sector owned and operated systems, with public sector regulation and monitoring.
  ? To create the road map, the team should draw upon the information collected during the site visits, the information compiled during the completion of the tasks for parts A and B, and the team's experience in developing comprehensive

hazardous and non-hazardous waste management systems.

V. Team Composition and Level of Effort

The following team will accomplish the tasks above in a three week period.

- Hazardous Waste Management Engineer (Expatriate) with extensive experience in the design, and management of hazardous waste management systems. The Engineer should also have specific experience in the design, construction, and operation of hazardous waste landfills.

  LOE = 20 days, including travel.

- Industrial Pollution Control Specialist (Egyptian) with extensive experience in pollution control and an understanding of hazardous waste management.

  LOE = 18 days (including 3 days preparation).

- Solid Waste Management Specialist (Expatriate) with extensive experience in the design of non-hazardous waste management systems, including experience with systems operated by the private sector.

  LOE = 16 days, including travel.

- Institutional Specialist (Expatriate) with experience in the Egyptian environmental sector. To be provided from the EEPP-PSU full-time staff.

  LOE = 10 days

- Translator to accompany Expatriate Specialists on site visits and assist with training.

  LOE = 6 days

- Translator to translate the design for the proposed hazardous waste landfill from Arabic into English.

  Fixed Fee (to be determined)

Appendix B

List of Contacts

Ministry of State for Environmental Affairs (MSEA) and Egyptian Environmental Affairs Agency (EEAA)

- Dr. Ahmad Hamza, Senior Technical Advisor
- Dr. Hoda El Shayed, Manager of Hazardous Waste Section, EEAA
- Eng. Amr Osama, EFNIC Program Coordinator
- Chem. Tarek Ramadan, EFNIC Program, 10R
- Agr. Eng. Osama El Nagar, EFNIC Program, 10R
- Mr. Islam Hamza, EFNIC Program, 6th of October (6O)

United States Agency for International Development

- Mr. Alan Davis, Chief, Environment Division
- Ms. Cheryl Jennings, Project Specialist, Environment Division
- Ms. Salwa Wahba, Project Specialist, Environment Division

10th of Ramadan City Development Agency

- Gen. Eng. Mohamad El Hawary, President
- Gen. Eng. Mahmoud Eid, Vise President
- Gen. Magdi Badawi, Director of Central Department for City Development
- Chem. Ahmad Abd-El Moula, Manager of Environment Department

6th of October City Development Agency

- Eng. Fawazy El Dosouki, Vise President
- Agr. Eng. Gamal Abd-El Aal, Ex-Manager of Cleanliness and Agriculture
- Eng. Mohamad Taher Abd-El Gawad, General Manager for Operation and Mainitenance
- Eng. Nadia Mohamad Abd-El Rahman, Environment Affairs Inspector

Investors

- Captain Reda-Allah Helmi, Chairman of 10R Board of Trustees (BOT)
- Chem. Louis Bishara, Chairman of 10R BOT Environment Committee
- Dr. Mahmoud Soliman, Chairman of 10R Investors Association
- Mousa Abu Hijleh, Deputy General Manager, UNIVERSAL factories in 6O
- Mr. Wael Shinawy, Director of Sadat City Investors Association

Consultants

- Mr. Aarno Kavvonius, Director Public Relations, EKOKEM (Finnida Contractor for Hazardous Waste landfill)
- Eng. Montaser Zahran, Owner and Director of Environmental Engineering Systems Group
- Prof. Osama Abd-El Gawad, Misr-Consult, Owner and General Director
- Dr. Ahmad Kasem, Misr-Consult, Director of Environmental Studies Department
- Dr. Fathy El Gamal, Misr Consult

Appendix C

Training Material
Presented at Hazardous Waste Training Events

Workshop for EFNIC Inspectors
Cairo, Egypt
December 19, 1999

Workshop for 10th of Ramadan Industrial Facilities Managers and Engineers
10th of Ramadan
March 26, 2000

Appendix D

Draft Hazardous Waste Lists Prepared by the Ministry of Industry and Mineral Resources

Appendix E

United States Hazardous Waste Classification System

Appendix F

Basel Convention Hazardous Waste Classification System

BASEL CONVENTION ON THE CONTROL TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL ADOPTED BY THE CONFERENCE OF THE PLENIPOTENTIARIES ON 22 MARCH 1989

Annex I

CATEGORIES OF WASTES TO BE CONTROLLED

<u>Waste Streams</u>

Y1 Clinical wastes from medical care in hospitals, medical centers and clinics

Y2 Wastes from the production and preparation of pharmaceutical products

Y3 Waste pharmaceuticals, drugs and medicines

Y4 Wastes from the production, formulation and use of biocides and phytopharmaceuticals

Y5 Wastes from the manufacture, formulation and use of wood preserving chemicals

Y6 Wastes from the production, formulation and use of organic solvents

Y7 Wastes from heat treatment and tempering operations containing cyanides

Y8 Waste mineral oils unfit for their originally intended use

Y9 Waste oils/water, hydrocarbons/water mixtures, emulsions

Y10 Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)

Y11 Waste tarry residues arising from refining, distillation and any pyrolytic treatment

Y12 Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish

Y13 Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives

Y14 Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known

Y15 Wastes of an explosive nature not subject to other legislation

Y16 Wastes from production, formulation and use of photographic chemicals and processing materials

Y17 Wastes resulting from surface treatment of metals and plastics

Y18 Residues arising from industrial waste disposal operations

<u>Wastes having as constituents:</u>

Y19 Metal carbonyls

Y20 Beryllium; beryllium compounds

Y21 Hexavalent chromium compounds

Y22 Copper compounds

Y23 Zinc compounds

Y24 Arsenic; arsenic compounds

Y25 Selenium; selenium compounds

Y26 Cadmium; cadmium compounds

Y27 Antimony; antimony compounds

Y28 Tellurium; tellurium compounds

Y29 Mercury; mercury compounds

Y30 Thallium; thallium compounds

Y31 Lead; lead compounds

Y32 Inorganic fluorine compounds excluding calcium fluoride

Y33 Inorganic cyanides

Y34 Acidic solutions or acids in solid form

Y35 Basic solutions or bases in solid form

Y36 Asbestos (dust and fibres)

Y37 Organic phosphorus compounds

Y38 Organic cyanides

Y39 Phenols; phenol compounds including chlorophenols

Y40 Ethers

Y41 Halogenated organic solvents

Y42 Organic solvents excluding halogenated solvents

Y43 Any congenor of polychlorinated dibenzo-furan

Y44 Any congenor of polychlorinated dibenzo-p-dioxin

Y45 Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)

<u>Notes</u>

(a) To facilitate the application of this Convention, and subject to paragraphs (b), (c) and (d), wastes listed in Annex VIII are characterized as hazardous pursuant to Article 1, paragraph 1 (a), of this Convention, and wastes listed in Annex IX are not covered by Article 1, paragraph 1 (a), of this Convention.

(b) Designation of a waste on Annex VIII does not preclude, in a particular case, the use of Annex III demonstrate that a waste is not hazardous pursuant to Article 1, paragraph 1 (a), of this Convention.

(c) Designation of a waste on Annex IX does not preclude, in a particular case, characterization of such a waste as hazardous pursuant to Article 1, paragraph 1 (a), of this Convention if it contains Annex I material to an extent causing it to exhibit an Annex III characteristic.

(d) Annexes VIII and IX do not affect the application of Article 1, paragraph 1 (a), of this Convention for purpose of characterization of wastes.(1)

Annex II

CATEGORIES OF WASTES REQUIRING SPECIAL CONSIDERATION

Y46 - Wastes collected from households

Y47 - Residues arising from the incineration of household wastes

Annex III

LIST OF HAZARDOUS CHARACTERISTICS

UN Class[1]/Code Characteristics

1/H1 Explosive

An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and such speed as to cause damage to the surroundings.

3/H3 Flammable liquids

The word "flammable" has the same meaning as "inflammable." Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5 C, closed-cup test, or not more than 65.6C, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)

4.1/H4.1 Flammable solids

Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.

4.2/H4.2 Substances or wastes liable to spontaneous combustion

Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.

4.3/H4.3 Substances or wastes which, in contact with water emit flammable gases

Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

5.1/H5.1 Oxidizing

Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.

5.2/H5.2 Organic Peroxides

Organic substances or wastes which contain the bivalent-O-O- structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.

[1] Corresponds to the hazard classification system included in the United Nations Recommendations on the Transport of Dangerous Goods (ST/SG/AC.10/1Rev.5, United Nations, New York, 1988)

6.1/H6.1 Poisonous (Acute)
Substances or wastes liable either to cause death or serious injury or to harm health if swallowed or inhaled or by skin contact.

6.2/H6.2 Infectious substances
Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans.

8/H8 Corrosives
Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.

9/H10 Liberation of toxic gases in contact with air or water
Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.

9/H11 Toxic (Delayed or chronic)
Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity.

9/H12 Ecotoxic
Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.

9/H13 Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

Tests

The potential hazards posed by certain types of wastes are not yet fully documented; tests to define quantitatively these hazards do not exist. Further research is necessary in order to develop means to characterize potential hazards posed to man and/or the environment by these wastes. Standardized tests have been derived with respect to pure substances and materials. Many countries have developed national tests which can be applied to materials listed in Annex I, in order to decide if these materials exhibit any of the characteristics listed in this Annex.

Annex VIII

LIST A

Wastes contained in this Annex are characterized as hazardous under Article 1, paragraph 1 (a), of this Convention, and their designation on this Annex does not preclude the use of Annex III to demonstrate that a waste is not hazardous.

A1 Metal and metal-bearing wastes

A1010 Metal wastes and waste consisting of alloys of any of the following:

- Antimony
- Arsenic
- Beryllium
- Cadmium
- Lead
- Mercury
- Selenium
- Tellurium
- Thallium

but excluding such wastes specifically listed on list B.

A1020 Waste having as constituents or contaminants, excluding metal waste in massive form, any of the following:

- Antimony; antimony compounds
- Beryllium; beryllium compounds
- Cadmium; cadmium compounds
- Lead; lead compounds
- Selenium; selenium compounds
- Tellurium; tellurium compounds

A1030 Wastes having as constituents or contaminants any of the following:

- Arsenic; arsenic compounds
- Mercury; mercury compounds.
- Thallium; thallium compounds

A1040 Wastes having as constituents any of the following:

- Metal carbonyls
- Hexavalent chromium compounds

A1050 Galvanic sludges

A1060 Waste liquors from the pickling of metals

A1070 Leaching residues from zinc processing, dust and sludges such as jarosite, hematite, etc.

A1080 Waste zinc residues not included on list B, containing lead and cadmium in concentrations sufficient to exhibit Annex III characteristics

A1090 Ashes from the incineration of insulated copper wire

A1100 Dusts and residues from gas cleaning systems of copper smelters

A1110 Spent electrolytic solutions from copper electrorefining and electrowinning operations

A1120 Waste sludges, excluding anode slimes, from electrolyte purification systems in copper electrorefining and electrowinning operations

A1130 Spent etching solutions containing dissolved copper

A1140 Waste cupric chloride and copper cyanide catalysts

A1150 Precious metal ash from incineration of printed circuit boards not included on list B[2]

A1160 Waste lead-acid batteries, whole or crushed

A1170 Unsorted waste batteries excluding mixtures of only list B batteries. Waste batteries not specified on list B containing Annex I constituents to an extent to render them hazardous.

A1180 Waste electrical and electronic assemblies or scrap[3] containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B B1110)[4]

<u>A2 Wastes containing principally inorganic constituents, which may contain metals and organic materials</u>

A2010 Glass waste from cathode-ray tubes and other activated glasses

A2020 Waste inorganic fluorine compounds in the form of liquids or sludges but excluding such wastes specified on list B

A2030 Waste catalysts but excluding such wastes specified on list B

A2040 Waste gypsum arising from chemical industry processes, when containing Annex I constituents to the extent that it exhibits an Annex III hazardous characteristic (note the related entry on list B B2080)

A2050 Waste asbestos (dusts and fibres)

A2060 Coal-fired power plant fly-ash containing Annex I substances in concentrations sufficient to exhibit Annex III characteristics (note the related entry on list B B2050)

<u>A3 Wastes containing principally organic constituents, which may contain metals and inorganic materials</u>

A3010 Waste from the production or processing of petroleum coke and bitumen

A3020 Waste mineral oils unfit for their originally intended use A3030 Wastes that contain,

---

[2] Note that mirror entry on list B (B1160) does not specify exceptions.
[3] This entry does not include scrap assemblies from electric power generation.
[4] PCBs are at a concentration level of 50 mg/kg or more.

consist of or are contaminated with leaded anti-knock compound sludges

A3040 Waste thermal (heat transfer) fluids

A3050 Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives excluding such wastes specified on list B (note the related entry on list B B4020)

A3060 Waste nitrocellulose

A3070 Waste phenols, phenol compounds including chlorophenol in the form of liquids or sludges

A3080 Waste ethers not including those specified on list B

A3090 Waste leather dust, ash, sludges and flours when containing hexavalent chromium compounds or biocides (note the related entry on list B B3100)

A3100 Waste paring and other waste of leather or of composition leather not suitable for the manufacture of leather articles containing hexavalent chromium compounds or biocides (note the related entry on list B B3090)

A3110 Fellmongery wastes containing hexavalent chromium compounds or biocides or infectious substances (note the related entry on list B B3110)

A3120 Fluff - light fraction from shredding

A3130 Waste organic phosphorous compounds

A3140 Waste non-halogenated organic solvents but excluding such wastes specified on list B

A3150 Waste halogenated organic solvents

A3160 Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations

A3170 Wastes arising from the production of aliphatic halogenated hydrocarbons (such as chloromethane, dichloro-ethane, vinyl chloride, vinylidene chloride, allyl chloride and epichlorhydrin)

A3180 Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), polychlorinated terphenyl (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more[5]

---

[5] The 50 mg/kg level is considered to be an internationally practical level for all wastes. However, many individual countries have established lower regulatory levels (e.g., 20 mg/kg) for specific wastes.

A3190 Waste tarry residues (excluding asphalt cements) arising from refining, distillation and any pyrolitic treatment of organic materials

<u>A4 Wastes which may contain either inorganic or organic constituents</u>

A4010 Wastes from the production, preparation and use of pharmaceutical products but excluding such wastes specified on list B

A4020 Clinical and related wastes; that is wastes arising from medical, nursing, dental, veterinary, or similar practices, and wastes generated in hospitals or other facilities during the investigation or treatment of patients, or research projects

A4030 Wastes from the production, formulation and use of biocides and phytopharmaceuticals, including waste pesticides and herbicides which are off-specification, outdated,[6] or unfit for their originally intended use

A4040 Wastes from the manufacture, formulation and use of wood-preserving chemicals[7]

A4050 Wastes that contain, consist of or are contaminated with any of the following:
- Inorganic cyanides, excepting precious-metal-bearing residues in solid form containing traces of inorganic cyanides
- Organic cyanides

A4060 Waste oils/water, hydrocarbons/water mixtures, emulsions

A4070 Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish excluding any such waste specified on list B (note the related entry on list B B4010)

A4080 Wastes of an explosive nature (but excluding such wastes specified on list B)

A4090 Waste acidic or basic solutions, other than those specified in the corresponding entry on list B (note the related entry on list B B2120)

A4100 Wastes from industrial pollution control devices for cleaning of industrial off-gases but excluding such wastes specified on list B

A4110 Wastes that contain, consist of or are contaminated with any of the following:
- Any congenor of polychlorinated dibenzo-furan
- Any congenor of polychlorinated dibenzo-dioxin

A4120 Wastes that contain, consist of or are contaminated with peroxides

A4130 Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics

---

[6] "Outdated" means unused within the period recommended by the manufacturer.
[7] This entry does not include wood treated with wood preserving chemicals.

A4140 Waste consisting of or containing off specification or outdated[8] chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics

A4150 Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on human health and/or the environment are not known

A4160 Spent activated carbon not included on list B (note the related entry on list B B2060)

Annex IX

LIST B

Wastes contained in the Annex will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic.

B1 Metal and metal-bearing wastes

B1010 Metal and metal-alloy wastes in metallic, non-dispersible form:

- Precious metals (gold, silver, the platinum group, but not mercury)
- Iron and steel scrap
- Copper scrap
- Nickel scrap
- Aluminium scrap
- Zinc scrap
- Tin scrap
- Tungsten scrap
- Molybdenum scrap
- Tantalum scrap
- Magnesium scrap
- Cobalt scrap
- Bismuth scrap
- Titanium scrap
- Zirconium scrap
- Manganese scrap
- Germanium scrap
- Vanadium scrap
- Scrap of hafnium, indium, niobium, rhenium and gallium
- Thorium scrap
- Rare earths scrap

B1020 Clean, uncontaminated metal scrap, including alloys, in bulk finished form (sheet, plate, beams, rods, etc), of:

- Antimony scrap

[8] "Outdated" means unused within the period recommended by the manufacturer.

- Beryllium scrap
- Cadmium scrap
- Lead scrap (but excluding lead-acid batteries)
- Selenium scrap
- Tellurium scrap

B1030 Refractory metals containing residues

B1040 Scrap assemblies from electrical power generation not contaminated with lubricating oil, PCB or PCT to an extent to render them hazardous

B1050 Mixed non-ferrous metal, heavy fraction scrap, not containing Annex I materials in concentrations sufficient to exhibit Annex III characteristics[9]

B1060 Waste selenium and tellurium in metallic elemental form including powder

B1070 Waste of copper and copper alloys in dispersible form, unless they contain Annex I constituents to an extent that they exhibit Annex III characteristics

B1080 Zinc ash and residues including zinc alloys residues in dispersible form unless containing Annex I constituents in concentration such as to exhibit Annex III characteristics or exhibiting hazard characteristic H4.3[10]

B1090 Waste batteries conforming to a specification, excluding those made with lead, cadmium or mercury

B1100 Metal-bearing wastes arising from melting, smelting and refining of metals:
- Hard zinc spelter
- Zinc-containing drosses:
- Galvanizing slab zinc top dross (>90% Zn) - Galvanizing slab zinc bottom dross (>92% Zn) - Zinc die casting dross (>85% Zn) - Hot dip galvanizers slab zinc dross (batch)(>92% Zn) - Zinc skimmings
- Aluminium skimmings (or skims) excluding salt slag
- Slags from copper processing for further processing or refining not containing arsenic, lead or cadmium to an extend that they exhibit Annex III hazard characteristics
- Wastes of refractory linings, including crucibles, originating from copper smelting
- Slags from precious metals processing for further refining
- Tantalum-bearing tin slags with less than 0.5% tin

[9] Note that even where low level contamination with Annex I materials initially exists, subsequent processes, including recycling processes, may result in separated fractions containing significantly enhanced concentrations of those Annex I materials.

[10] The status of zinc ash is currently under review and there is a recommendation with the United Nations Conference on Trade and Development (UNCTAD) that zinc ashes should not be dangerous goods.

B1110 Electrical and electronic assemblies:

- Electronic assemblies consisting only of metals or alloys
- Waste electrical and electronic assemblies or scrap[11] (including printed circuit boards) not containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or not contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) or from which these have been removed, to an extent that they do not possess any of the characteristics contained in Annex III (note the related entry on list A A1180)
- Electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse,[12] and not for recycling or final disposal[13]

B1120 Spent catalysts excluding liquids used as catalysts, containing any of:

Transition metals, excluding waste catalysts (spent catalysts, liquid used catalysts or other catalysts) on list A:

Scandium	Vanadium	Manganese	Cobalt
Copper	Yttrium	Niobium	Hafnium
Tungsten	Titanium	Chromium	Iron
Nickel	Zinc	Zirconium	Molybdenum
Tantalum	Rhenium		

Lanthanides (rare earth metals):

Lanthanum	Praseodymium	Samarium	Gadolinium
Dysprosium	Erbium	Ytterbium	Cerium
Neody	Europium	Terbium	Holmium
Thulium	Lutetium		

B1130 Cleaned spent precious-metal-bearing catalysts

B1140 Precious-metal-bearing residues in solid form which contain traces of inorganic cyanides

B1150 Precious metals and alloy wastes (gold, silver, the platinum group, but not mercury) in a dispersible, non-liquid form with appropriate packaging and labelling

B1160 Precious-metal ash from the incineration of printed circuit boards (note the related entry on list A A1150)

B1170 Precious-metal ash from the incineration of photographic film

B1180 Waste photographic film containing silver halides and metallic silver

---

[11] This entry does not include scrap from electrical power generation.
[12] Reuse can include repair, refurbishment or upgrading, but not major reassembly.
[13] In some countries these materials destined for direct re-use are not considered wastes.

B1190 Waste photographic paper containing silver halides and metallic silver

B1200 Granulated slag arising from the manufacture of iron and steel

B1210 Slag arising from the manufacture of iron and steel including slags as a source of TiO2 and vanadium

B1220 Slag from zinc production, chemically stabilized, having a high iron content (above 20%) and processed according to industrial specifications (e.g., DIN 4301) mainly for construction

B1230 Mill scaling arising from the manufacture of iron and steel

B1240 Copper oxide mill-scale

B2 Wastes containing principally inorganic constituents, which may contain metals and organic materials

B2010 Wastes from mining operations in non-dispersible form:
- Natural graphite waste
- Slate waste, whether or not roughly trimmed or merely cut, by sawing or otherwise
- Mica waste
- Leucite, nepheline and nepheline syenite waste
- Feldspar waste
- Fluorspar waste
- Silica wastes in solid form excluding those used in foundry operations

B2020 Glass waste in non-dispersible form:
- Cullet and other waste and scrap of glass except for glass from cathode-ray tubes and other activated glasses

B2030 Ceramic wastes in non-dispersible form:
- Cermet wastes and scrap (metal ceramic composites)
- Ceramic based fibres not elsewhere specified or included

B2040 Other wastes containing principally inorganic constituents:
- Partially refined calcium sulphate produced from flue-gas desulphurization (FGD)
- Waste gypsum wallboard or plasterboard arising from the demolition of buildings
- Slag from copper production, chemically stabilized, having a high iron content (above 20%) and processed according to industrial specifications (e.g., DIN 4301 and DIN 8201) mainly for construction and abrasive applications
- Sulphur in solid form
- Limestone from the production of calcium cyanamide (having a pH less than 9)
- Sodium, potassium, calcium chlorides
- Carborundum (silicon carbide)
- Broken concrete
- Lithium-tantalum and lithium-niobium containing glass scraps

B2050 Coal-fired power plant fly-ash, not included on list A (note the related entry on list A

A2060)

B2060 Spent activated carbon resulting from the treatment of potable water and processes of the food industry and vitamin production (note the related entry on list A A4160)

B2070 Calcium fluoride sludge

B2080 Waste gypsum arising from chemical industry processes not included on list A (note the related entry on list A A2040)

B2090 Waste anode butts from steel or aluminium production made of petroleum coke or bitumen and cleaned to normal industry specifications (excluding anode butts from chlor alkali electrolyses and from metallurgical industry)

B2100 Waste hydrates of aluminium and waste alumina and residues from alumina production excluding such materials used for gas cleaning, flocculation or filtration processes

B2110 Bauxite residue ("red mud") (pH moderated to less than 11.5)

B2120 Waste acidic or basic solutions with a pH greater than 2 and less than 11.5, which are not corrosive or otherwise hazardous (note the related entry on list A A4090)

B3 Wastes containing principally organic constituents, which may contain metals and inorganic materials

B3010 Solid plastic waste:
The following plastic or mixed plastic materials, provided they are not mixed with other wastes and are prepared to a specification:

- Scrap plastic of non-halogenated polymers and co-polymers, including but not limited to the following:[14]
    - ethylene
    - styrene
    - polypropylene
    - polyethylene terephthalate
    - acrylonitrile
    - butadiene
    - polyacetals
    - polyamides
    - polybutylene terephthalate
    - polycarbonates
    - polyethers
    - polyphenylene sulphides
    - acrylic polymers
    - alkanes C10-C13 (plasticiser)
    - polyurethane (not containing CFCs)
    - polysiloxanes

[14] It is understood that such scraps are completely polymerized.

- polymethyl methacrylate
  - polyvinyl alcohol
  - polyvinyl butyral
  - polyvinyl acetate
- Cured waste resins or condensation products including the following:
  - urea formaldehyde resins
  - phenol formaldehyde resins
  - melamine formaldehyde resins
  - epoxy resins
  - alkyd resins
  - polyamides
- The following fluorinated polymer wastes:[15]
  - perfluoroethylene/propylene (FEP)
  - perfluoroalkoxy alkane (PFA)
  - perfluoroalkoxy alkane (MFA)
  - polyvinylfluoride (PVF)
  - polyvinylidenefluoride (PVDF)

B3020 Paper, paperboard and paper product wastes

The following materials, provided they are not mixed with hazardous wastes:

Waste and scrap of paper or paperboard of:

- unbleached paper or paperboard or of corrugated paper or paperboard
- other paper or paperboard, made mainly of bleached chemical pulp, not coloured in the mass
- paper or paperboard made mainly of mechanical pulp (for example, newspapers, journals and similar printed matter)
- other, including but not limited to 1) laminated paperboard 2) unsorted scrap.

B3030 Textile wastes

The following materials, provided they are not mixed with other wastes and are prepared to a specification:

- Silk waste (including cocoons unsuitable for reeling, yarn waste and garnetted stock)
- not carded or combed other
- Waste of wool or of fine or coarse animal hair, including yarn waste but excluding garnetted stock
- noils of wool or of fine animal hair other waste of wool or of fine animal hair waste of coarse animal hair
- Cotton waste (including yarn waste and garnetted stock)
- yarn waste (including thread waste) garnetted stock other
- Flax tow and waste
- Tow and waste (including yarn waste and garnetted stock) of true hemp (Cannabis sativa L.)
- Tow and waste (including yarn waste and garnetted stock) of jute and other textile bast fibres (excluding flax, true hemp and ramie)

---

[15] Post-consumer wastes are excluded from this entry

- Tow and waste (including yarn waste and garnetted stock) of sisal and other textile fibres of the genus Agave
- Tow, noils and waste (including yarn waste and garnetted stock) of coconut
- Tow, noils and waste (including yarn waste and garnetted stock) of abaca (Manila hemp or Musa textilis Nee)
- Tow, noils and waste (including yarn waste and garnetted stock) of ramie and other vegetable textile fibres, not elsewhere specified or included
- Waste (including noils, yarn waste and garnetted stock) of man-made fibres
- of synthetic fibres of artificial fibres
- Worn clothing and other worn textile articles
- Used rags, scrap twine, cordage, rope and cables and worn out articles of twine, cordage, rope or cables of textile materials
- sorted other B3040 Rubber wastes

The following materials, provided they are not mixed with other wastes:

- Waste and scrap of hard rubber (e.g., ebonite)
- Other rubber wastes (excluding such wastes specified elsewhere)

B3050 Untreated cork and wood waste:

- Wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms
- Cork waste: crushed, granulated or ground cork

B3060 Wastes arising from agro-food industries provided it is not infectious:

- Wine lees
- Dried and sterilized vegetable waste, residues and byproducts, whether or not in the form of pellets, of a kind used in animal feeding, not elsewhere specified or included
- Degras: residues resulting from the treatment of fatty substances or animal or vegetable waxes
- Waste of bones and horn-cores, unworked, defatted, simply prepared (but not cut to shape), treated with acid or degelatinised
- Fish waste
- Cocoa shells, husks, skins and other cocoa waste
- Other wastes from the agro-food industry excluding by-products which meet national and international requirements and standards for human or animal consumption

B3070 The following wastes:

- Waste of human hair
- Waste straw
- Deactivated fungus mycelium from penicillin production to be used as animal feed

B3080 Waste parings and scrap of rubber

B3090 Paring and other wastes of leather or of composition leather not suitable for the manufacture of leather articles, excluding leather sludges, not containing hexavalent chromium compounds and biocides (note the related entry on list A A3100)

B3100 Leather dust, ash, sludges or flours not containing hexavalent chromium compounds or biocides (note the related entry on list A A3090)

B3110 Fellmongery wastes not containing hexavalent chromium compounds or biocides or infectious substances (note the related entry on list A A3110)

B3120 Wastes consisting of food dyes

B3130 Waste polymer ethers and waste non-hazardous monomer ethers incapable of forming peroxides

B3140 Waste pneumatic tyres, excluding those destined for Annex IVA operations

B4 Wastes which may contain either inorganic or organic constituents

B4010 Wastes consisting mainly of water-based/latex paints, inks and hardened varnishes not containing organic solvents, heavy metals or biocides to an extent to render them hazardous (note the related entry on list A A4070)

B4020 Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives, not listed on list A, free of solvents and other contaminants to an extent that they do not exhibit Annex III characteristics, e.g., water-based, or glues based on casein starch, dextrin, cellulose ethers, polyvinyl alcohols (note the related entry on list A A3050)

B4030 Used single-use cameras, with batteries not included on list A

Appendix G

EPA Sector Notebooks

The EPA's Office of Enforcement and Compliance Assurance has developed a series of profiles or notebooks containing information on selected major industries. These notebooks, which focus on key indicators that holistically present air, water, and land pollutant release data, have been thoroughly reviewed by experts from both inside and outside the EPA.

Each Notebook brings you comprehensive, well-researched details gathered for the first time in a single source and includes:

- a comprehensive environmental profile
- industrial process information
- pollution prevention techniques
- pollutant release data
- regulatory requirements
- compliance/enforcement history
- government and industry partnerships
- innovative programs
- contact names
- bibliographic
- references
- description of research methodology

The notebooks are on-line at http://es.epa.gov/oeca/sector/index.html. Most Internet browsers will allow you to read the PDF versions of the Notebooks. If your Internet browser does not allow you to read the PDF versions of the Notebooks on-line you may want to see an example Notebook, the Profile of the Metal Fabrication Industry, which can be read on-line (in HTML).

Available Industry Sector Notebooks

- Profile of the Agricultural Chemical, Pesticide and Fertilizer Industry (1999) (coming soon)
- Profile of the Agricultural Crop Production Industry (1999) (coming soon)
- Profile of the Agricultural Livestock Production Industry (1999) (coming soon)
- Profile of the Aerospace Industry (1998) (new)
- Profile of the Air Transportation Industry (1997)
- Profile of the Dry Cleaning Industry (1995)
- Profile of the Electronics and Computer Industry (1995) **
- Profile of the Fossil Fuel Electric Power Generation Industry (1997)
- Profile of the Ground Transportation Industry (1997)
- Profile of the Inorganic Chemical Industry (1995) **
- Profile of the Iron and Steel Industry (1995)
- Profile of the Lumber and Wood Products Industry (1995)
- Profile of the Metal Casting Industry (1997)

- Profile of the Metal Fabrication Industry (1995) (html) **
- Profile of the Metal Mining Industry (1995)
- Profile of the Motor Vehicle Assembly Industry (1995)
- Profile of the Nonferrous Metals Industry (1995)
- Profile of the Non-Fuel, Non-Metal Mining Industry (1995)
- Profile of the Oil and Gas Extraction Industry (1999) (new)
- Profile of the Organic Chemical Industry (1995) **
- Profile of the Petroleum Refining Industry (1995)
- Profile of the Pharmaceutical Industry (1997)
- Profile of the Plastic Resins and Man-made Fibers Industry (1997)
- Profile of the Printing Industry (1995)
- Profile of the Pulp and Paper Industry (1995)
- Profile of the Rubber and Plastic Industry (1995)
- Profile of the Shipbuilding and Repair Industry (1997)
- Profile of the Stone, Clay, Glass and Concrete Industry (1995)
- Profile of the Textiles Industry (1997)
- Profile of the Transportation Equipment Cleaning Industry (1995)
- Profile of the Water Transportation Industry (1997)
- Profile of the Wood Furniture and Fixtures Industry (1995)

Obtaining Copies

Free electronic copies of the Notebooks can be downloaded from http://es.epa.gov/oeca/sector/index.html in PDF or other formats. The Word Perfect files may take several minutes to download due to the size of the Notebooks. Adobe Acrobat Reader (for PDF files) instructions and software are available free of charge.

Printed copies can be ordered for a fee of between $6 and $25, depending on length, from the Government Printing Office (GPO) by calling (202) 512-1800 or by linking directly to the GPO Sales Product Catalog . Be sure to search using "sector notebook" or the exact title of the document (Profile of the xxxxx Industry). (For federal state and local government employees and libraries only) Contact EPA's National Service Center for Environmental Publications (NSCEP) online or call at (800) 490-9198 for free printed copies of any Notebook, while supplies last. When ordering, be ready with the exact title (Profile of the xxxxx Industry) or the EPA publication number (see below).

Questions or Comments

If you have questions or comments about the Industry Sector Notebook Project contact:

Seth Heminway
phone: (202) 564-7017
fax: (202) 564-0050
E-mail: heminway.seth@epa.gov
Seth Heminway (2223A)
US EPA 401 M St. S.W.
Washington, DC 20460, USA

Appendix H

Excerpts from the USEPA/OECA Fabricated Metal Sector Notebook

Appendix I

Flow Diagrams for 10 Types of Industrial Facilities

Appendix K

"Designing and Installing Liners: Technical Considerations for Surface Impoundments, Landfills and Waste Piles"

Chapter 7B of the Guide for Industrial Waste Management, 1999, OSWER, USEPA, Washington, DC.

Appendix L

General Outline
Landfill Operations Plan

EXECUTIVE SUMMARY

1. INTRODUCTION
- 1.1. The Site
- 1.2. The Problem
  - 1.2.1. Operations
  - 1.2.2. Environmental
- 1.3. Program Objectives
  - 1.3.1. Setting Operational and Environmental Goals
  - 1.3.2. Developing Target Performance Standards
  - 1.3.3. Managing to Reduce Risks

2. MEETING OBJECTIVES IN OPERATIONS
- 2.1. Approach
- 2.2. Data Evaluation
  - 2.2.1. Site Characteristics
    - 2.2.1.1. Topography
    - 2.2.1.2. Geology
    - 2.2.1.3. Water
  - 2.2.2. Waste Generation
    - 2.2.2.1. Population
    - 2.2.2.2. Waste Generation Rates
    - 2.2.2.3. Nature of Wastes (Hazardous, non-hazardous, medical, etc.)
    - 2.2.2.4. Waste Generation Database
  - 2.2.3. Waste Collection Practices
    - 2.2.3.1. Domestic
    - 2.2.3.2. Industrial
    - 2.2.3.3. Medical
  - 2.2.4. Environmental
    - 2.2.4.1. Air
    - 2.2.4.2. Water
- 2.3. Hazards
  - 2.3.1. Air Pollution – Fires
  - 2.3.2. Air Pollution – Dust
  - 2.3.3. Groundwater Pollution – Leachate
  - 2.3.4. Health and Safety – Direct Contact